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APRIL 1957

Precision Metal Molding

PMM

INCLUDING DIE CASTINGS MAGAZINE

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INVESTMENT CASTINGS

PERMANENT MOLD CASTINGS

PLASTER MOLD CASTINGS

POWDER METALLURGY

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see page 3

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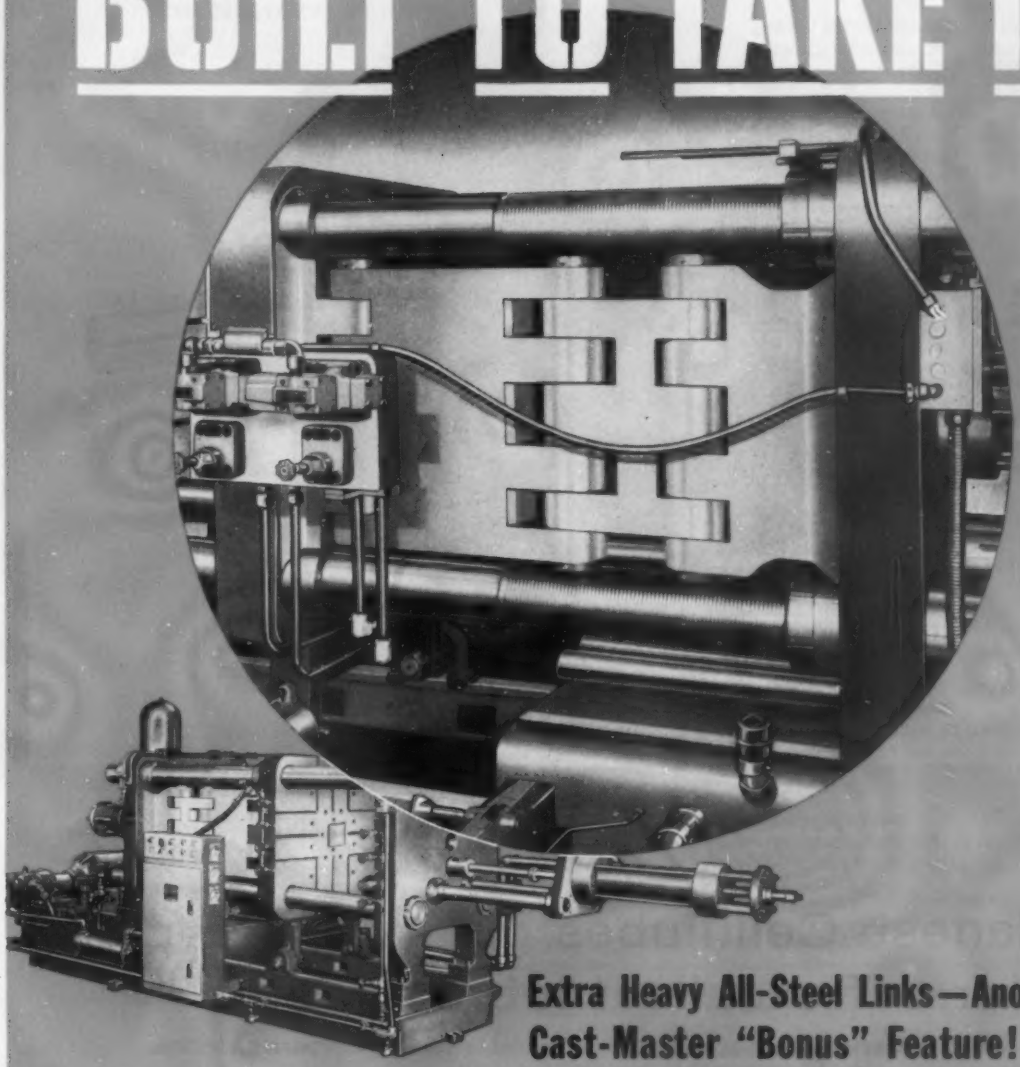

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April 1957:
Volume 15 Number 4

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BETWEEN THE LINES

the editor's viewpoint on articles in current and forthcoming issues

YOUR DESIGN CHECKLIST for powdered metal parts is an innovation in this year's Powder Metallurgy Directory, beginning on page 72. Whether you are working on a brand new design, or the redesign of a part that is being made by another process, there are certain basic factors you should consider. In order not to overlook any pertinent design or cost factor, we suggest that you make use of the check sheet, plus the detailed analysis.

VACUUM AGAIN! We have received so many questions about the prospects for vacuum die casting on a full production basis, that we have handed the questions over to two jobbing die casters for reply. These die casters now have experience using vacuum methods for making castings for electroplating. The comments of the first of these starts in this issue on page 111.

BACK IN NOVEMBER 1956, we passed along to you the results of a government investigation into the Prospect for Precision Steel Castings in Aircraft. One of the important conclusions was that many parts now being made as forged, machined and welded units, would be better and more economical as investment castings. Now, in this issue we are spelling out these conclusions in terms of some actual steel castings that are being used to save weight and money in aircraft construction. The story starts on page 31.

THE SECOND BEST YEAR in the history of the die casting industry was chalked up in 1956, with prospects that 1957 will climb back to the record 1955 levels. But an analysis of the shipment of die castings last year is worth studying. Breakdown by end product, comparative tonnages by alloy, and dollar value of casting shipments are all contained in an annual round-up report on die casting in 1956 beginning on page 38.

A CONCISE INTRODUCTION to each of the six PMM processes, together with information on where they are being used industrially today, will form the central theme of the May issue of PMM. The "Idea File" on PMM Processes will be timed for the two big design shows that month . . . the Design Engineering Show and the Engineered Casting Show.

TRIM PRESSES ARE BASIC to the die casting process. There is always a certain amount of flash, gates and vents to be removed. Yet little has been written on this phase of the die casting operation because it is assumed that little engineering is required to plan an efficient trimming setup. How one major die caster is using hydraulic trim presses will present some interesting food for thought in the May issue of PMM.

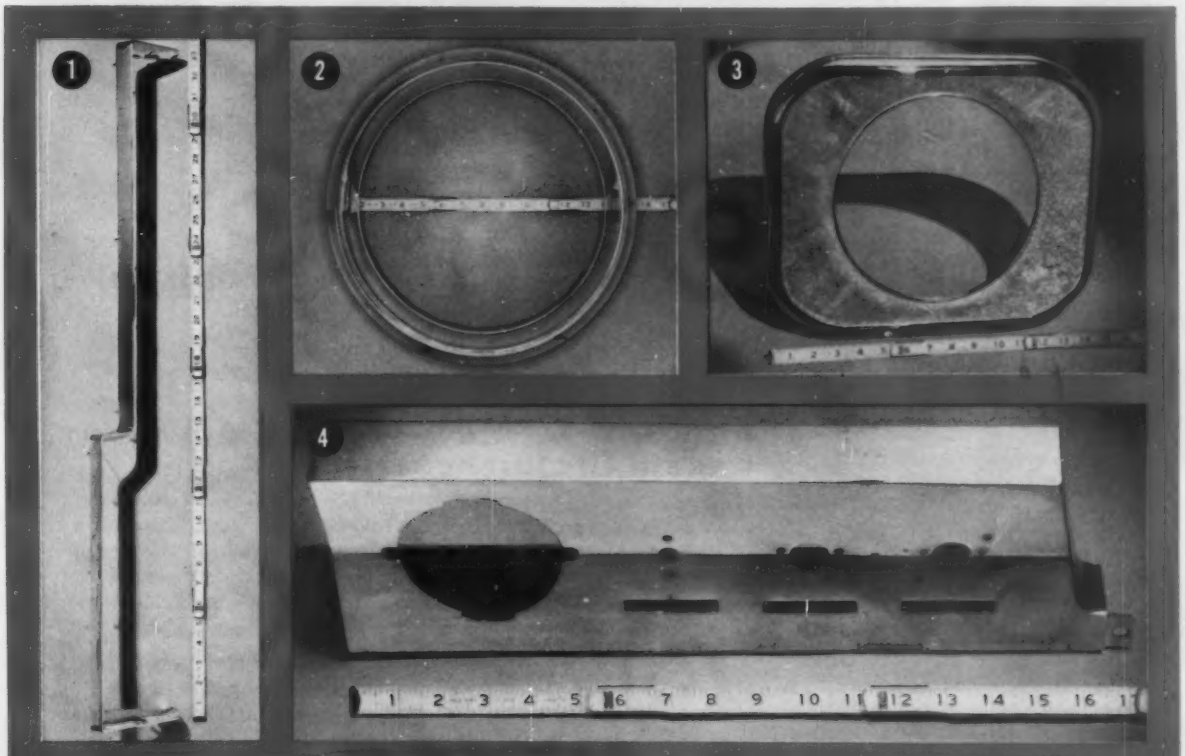
REED Vacucast Machine

BOOSTS PRODUCTION 32%—CUTS REJECTS BY 90%

These production figures are the improvements Lee Silver Service of Detroit, found in using its new Reed-Prentice Vacucast system. After 6 months of rugged, continuous zinc die-casting service, President Lee Radke cites the major advantages of his REED Vacucast:

- Surface quality of castings is greatly improved.
- Hardness and strength of castings are increased.
- Production is substantially increased.
- Ejection is extremely easy.
- An appreciable savings in metal is now possible due to a permissible decrease in wall thickness.
- Rejects are cut to less than 2%.

If you're producing zinc die castings, the exclusive REED Vacucast System can increase your production and your profits. For full details, write today to Reed-Prentice Corporation, 677 Cambridge Street, Worcester 4, Massachusetts.



1. The REED Vacucast raised production 32% and cut reject rate from 9% to 2% by overcoming difficulty of shooting metal to extreme ends of die. Ejection was easier, finish improved and castings less porous.

2. REED Vacucast eliminated webs and reduced size of gates and runners, cut total weight of shot by 4 lbs. Production was boosted from 97 to 131 parts an hour, and reject rate reduced from 15% to less than 2%.

3. Production on this appliance part was increased from 100 to 131 an hour, reject rate cut from 20% to under 2%. REED Vacucast improved casting skin and density so that higher heat could be applied for better paint-to-part bond.

4. This zinc appliance part could not be made successfully through straight die casting. Using the REED Vacucast, Lee Silver Service produces 135 parts an hour, with a reject rate well under 2%.

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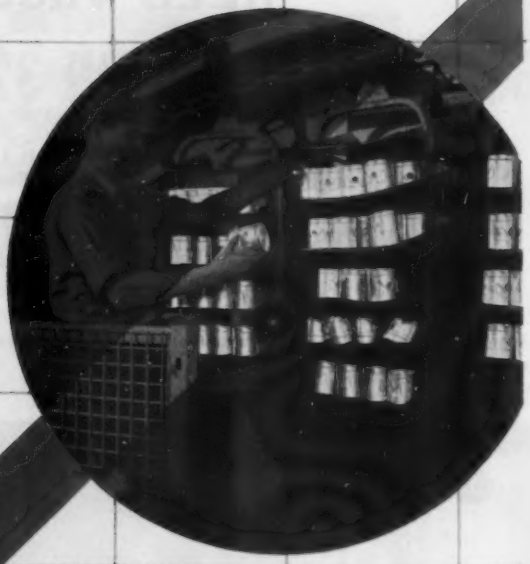
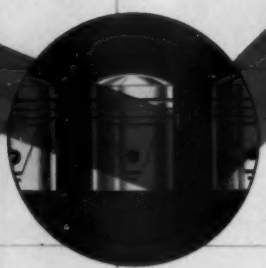


Castings production up... *from 18 to* 128 *pieces per hour per man!*



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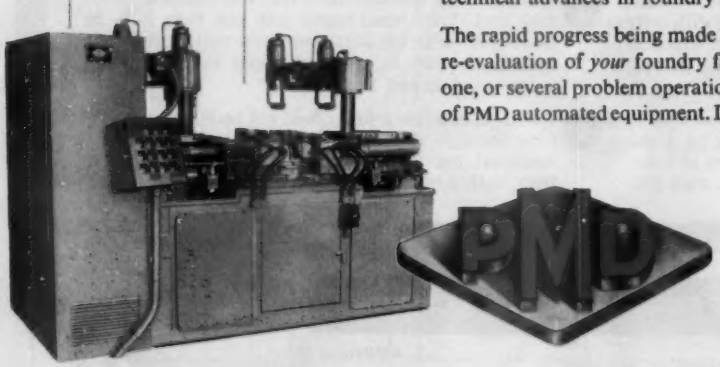
... and in your foundry operation—it could be the difference between profit and loss. Amazing production increases have been achieved in many foundry operations through the application of PMD automated machines and mechanized molding equipment. As one of the leading independent producers of tooling for light alloy molding and casting, PMD has worked closely with foundrymen in the development of automated foundry equipment.

Among these developments is the PMD AUTOMATED PISTON MOLDING MACHINE illustrated below. To provide increased output, lowered unit costs and higher quality castings, PMD applied its experience and engineering know-how to the problem. Result: an increase of over 600% ... in less floor space, and with marked improvement in piston quality. This is typical of many technical advances in foundry automation pioneered by PMD.

The rapid progress being made in light alloy casting methods warrants careful re-evaluation of *your* foundry facilities and production potential. If you have one, or several problem operations, it will pay you to investigate the advantages of PMD automated equipment. Discuss your requirements with a PMD engineer.



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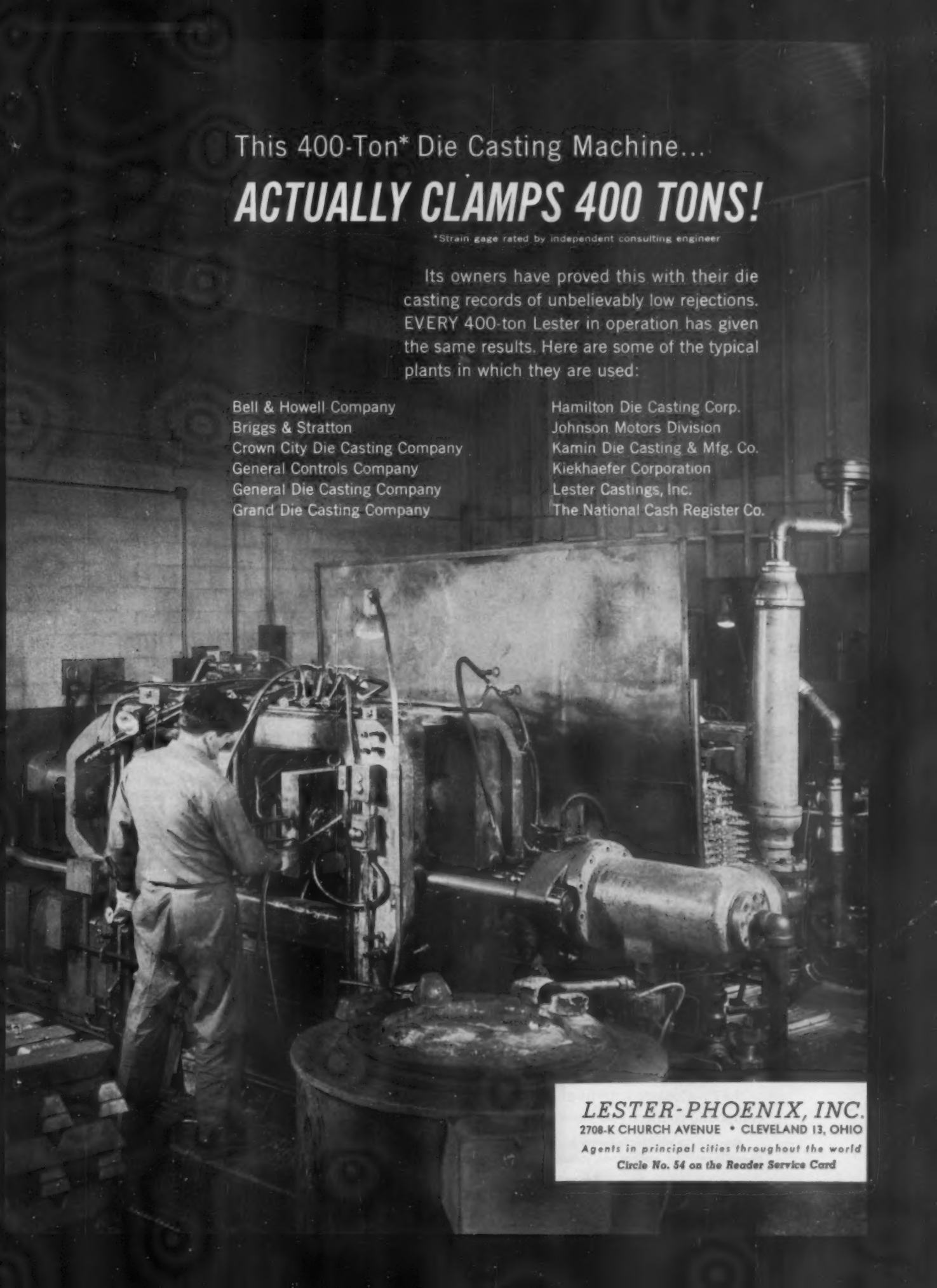
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CASTING ABOUT

technical news of applications
& processes involving precision metal moldings

DIE CAST JACK-KNIFE measuring only 1¼ inches from the tip of the blade to the end of the handle is the latest demonstration of the Intercast process. Cast complete with pivoting blade in a single operation, the tiny jack-knives are ready to use as they come from the machine. Gries Reproducer Corp. of New Rochelle, N.Y., which has developed and patented the automatic die casting machine to cast two-piece assemblies, has previously given out millions of miniature scissors and pliers, also made by Intercasting. Samples of the newest gadget can be obtained free by writing a letter to the editors of PMM. While these jack-knives are intended principally as novelties and premiums to demonstrate a unique casting method, it has also been used for commercial production of such pieces as binder rings for loose leaf notebooks, swiveling hangers for picture frames, etc.

STRIP MATERIAL ROLLED DIRECTLY FROM METAL POWDERS is one of the new developments in nuclear technology. Demonstrated publicly for the first time in March is a powder metal rolling mill designed and built by the Nuclear Division of Stanat Manufacturing Company, Inc., primarily as a tool for processing fuel elements used in nuclear reactors. Experimental fore-runners of the new machine successfully produced strip from such powders as aluminum, brass, copper, nickel, nickel-iron, molybdenum, tantalum, stainless steel and other ferrous alloys. The technique of rolling metal powders into strip is said to compare favorably with both the wrought and die-compacting and sintering methods of metallurgical processing. Studies made by rolling 18-8 stainless powder revealed it is possible to produce strips of high density, good ductility, high tensile strength, good corrosion resistance and desirable crystallographic orientation. First order for the new Stanat mill came from the Martin Company who are calling for early delivery on two units to its Nuclear Division in Baltimore.

ENGINEERING CHANGES IN THE EXPERIMENTAL MODELS of a die cast aluminum carburetor are made by inert arc welding at the new Hazel Park plant of Owens Welding Company. This saves considerable tooling cost and time while details are being worked out. Technique calls for preheating the casting to 600 F and welding it, using 40-60 amps, ⅛" 5 percent silicon rod and argon shielding gas. Modeling clay which shows changes to be made is removed just before welding.

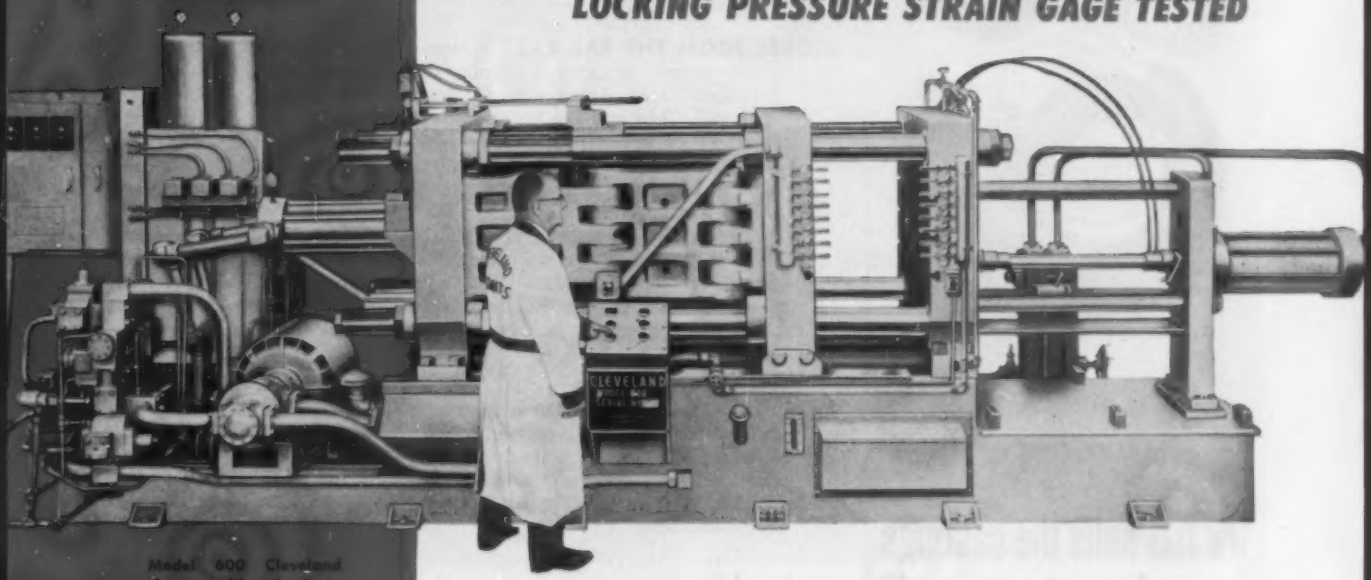
Continued on page 12

MODEL 600

GREATEST CLEVELAND YET!

New 600-Ton Universal Hydraulic Die Casting Machine

LOCKING PRESSURE STRAIN GAGE TESTED



Model 600 Cleveland shown with aluminum shot end. Also available as a hot chamber machine. Has 46½" x 46" die plates; 28" x 28" space between tie bars; 30" max.—10" min. die thickness; 8" - 15" die opening.

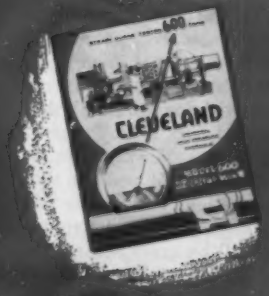
You're looking at the finest 600-ton die casting machine available today! The new Model 600 Cleveland was designed in every detail to give the die casting industry a machine of exceptional performance capabilities . . . high speed, reliable operation . . . safe and simple control . . . minimum maintenance. The developed machine more than met these specifications.

This new Cleveland will deliver castings weighing up to 10 lbs. aluminum, 25 lbs. zinc. An idea of the brawn built into the design—to back up its guaranteed 600-ton locking pressure—is indicated by the 38,000 lbs. net weight of the cold chamber machine shown above. Massive toggle system, 5" dia. tie bars and cross head guide bars, 7¾" thick platens, insure rigidity and accurate die alignment.

The hydraulic system is practically as leak-proof as can be built. Manifold valving is incorporated. Total pump capacity is 99 gpm. A 200 gal. oil reservoir is provided. Filter capacity is twice pump capacity. Two accumulators provide high injection speed.

Dozens of other highly important features—many are exclusively Cleveland's—are incorporated. You'll want to call in a Cleveland sales engineer for full details. In the meantime, factual information, well illustrated, in Bulletin 600 will give you plenty of incentive to reserve floor space for this new Cleveland in your shop. Write now for your copy.

Write for Bulletin 600



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Finding the right source for investment castings and the equipment and alloys for making them can be difficult . . . unless you rely upon the authentic listings in PMM's June issue. It will tell you who makes investment castings in which alloys, complete with alphabetical and geographical cross reference. As an added feature, it will contain many pages of reference data. Watch for . . .

The 2nd Annual

INVESTMENT CASTING DIRECTORY

If you sell investment castings or the alloys or equipment for making them, your ad in the June issue of PRECISION METAL MOLDING will be read and saved for a whole year.

CASTING ABOUT

continued from page 10

WITHOUT INDUCTION HEATING, there would be no modern electronics because there would be no vacuum tubes, no transistors, no permanent magnets or nickel chrome resistance alloys, according to a new 20-page history of high frequency induction heating just published. The atomic bomb, jets and missiles, and the "supermetals" are also dependent upon induction heating, the booklet points out. Melting and casting are covered in the publication, "Dr. Northrup's 'Fireless-Wireless' Furnace" available now from Ajax Electrothermic Corp.

NICKEL FROM THE FAR EAST is becoming an important factor in the world supply situation. A study being undertaken now by the Japanese Nickel Association to determine the supply of nickel ore in Brazil, Cuba and the Philippines points up the increasing role of Japanese exporters in the nickel market. Studies will also be made of the nickel products made locally or imported, and the quality of ores required, in Australia, France, Greece, the United States and West Germany.

Reports of the discovery of rich nickel and cobalt deposits in Netherlands New Guinea have been revealed in a Netherlands government memorandum. The deposits are said to be estimated in the millions of tons. Possible exploitation of the deposits is now being investigated by interests in Holland and abroad.

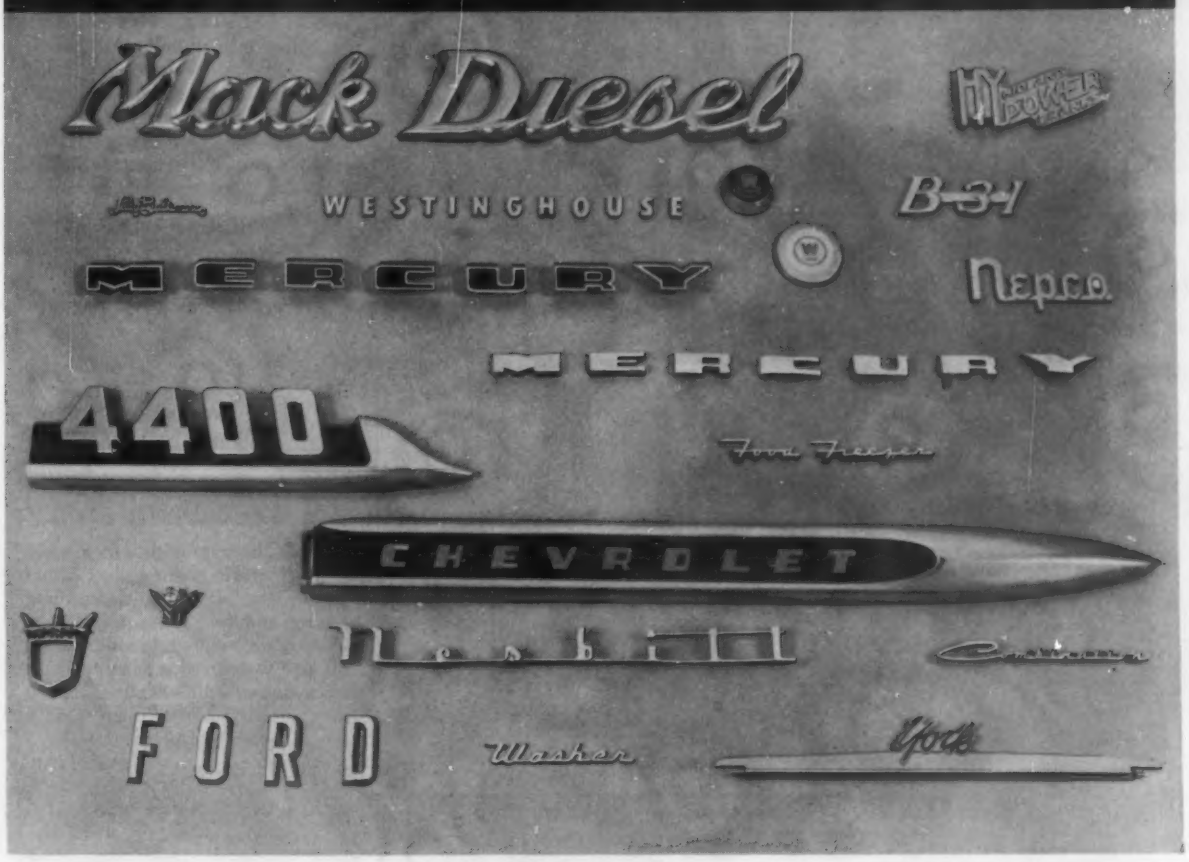
NEW USE FOR TITANIUM is in anodizing racks, welded of titanium Z-sections. The new type racks, made and patented by Robé, Inc., of Springfield, Va., are made of Rem-Cru's A-55 alloy, which has high corrosion resistance and formability. Titanium fingers set into grooves act as contact points for anodizing parts of widely varying shape and size.

CASTING FULL-SIZE CERMET TURBINE BLADES has been made possible by research at one of the flight propulsion laboratories, it has recently been learned. Titanium carbide, and a small amount of binder, is cast in mold and frozen to retain the mold shape. The casting is then dried by sublimation, sintered or semi-sintered and infiltrated. This is said to be less expensive than present methods which require grinding to shape the fully sintered or semi-sintered blanks of refractory carbides, oxides, silicides, borides and cermets.

FINER THAN THE PARTICLES IN CIGARETTE SMOKE, a new type of iron "dust" is the basis for a revolutionary new and potentially super-strong magnet. Unique properties of this magnet, developed by General Electric researchers, are achieved by precisely controlling the size and shape of individual iron particles so small that there are more than a billion billion in a pound. Dr. T. O. Paine of the company's Instrument Department at Lynn, Mass., recently told the American Association for the Advancement of Science that the ultra-fine particle iron magnet can theoretically be made ten times stronger than the best available magnets. Although experimental magnets have already been made, it will be quite some time before they will be commercially available. In accepting a citation from the AAAS for this development, E. E. Parker, general manager of the Instrument Department commented, "The new magnet will result in electric instruments that are smaller, lighter, more accurate and more rugged, making possible significant advances in instrumentation". He foresees better photographic exposure meters, aircraft instruments and other products using permanent magnets.

Continued on page 14

Nameplates—Ornaments—Medallions—Emblems



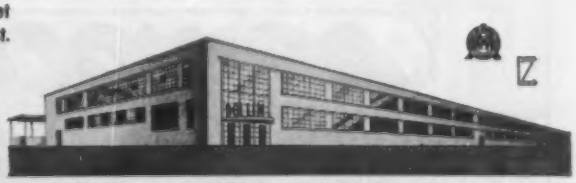
Unlimited designs—sizes—finishes at lowest cost, when

DIE-CAST BY DOLLIN

Hundreds of America's leading brands and products are attractively identified with Dollin zinc die-cast trademarks and ornaments. The great versatility of Dollin die-casting reproduces the full character and beauty of any design—whether massive or delicately intricate.

Dollin die-casting keeps costs low because parts are cast in a single operation—or with a minimum of secondary operations—at high production speeds. Dollin will carry your designs right through from drawings to complete parts, delivered ready for assembly. Available with cast holes—or with studs, cast or driven, smooth or threaded. Choice of chrome, brass or gold plating, painting, lacquering or other finish desired.

Send us drawings or samples of your nameplates or ornaments. Let Dollin engineers get the most out of your designs, at the lowest cost.



DOLLIN Zinc & Aluminum DIE-CASTINGS

Dollin Corporation 614 So. 21st St., Irvington 11, N. J.

SALES OFFICES: Boston • Buffalo • Canton • Charlotte • Chicago • Detroit • Louisville • Philadelphia • Pittsburgh • St. Louis • St. Paul

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ARWOOD Investment Casting may be the answer to your design problems when ferrous or non-ferrous parts or components must be of intricate shape and unusual contour, of metals difficult or impossible to machine.

Problems like configuration, alloy selection, tolerances, surface finish and inspection standards affect production cost and performance. Choose wisely . . . Choose ARWOOD for design assistance and production efficiency.

For complete information on Precision Investment Casting, write TODAY.

ARWOOD

ARWOOD PRECISION CASTING CORP.
323 West 44th Street, New York 36, N. Y.
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"PIONEERS IN INVESTMENT CASTING"

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CASTING ABOUT

continued from page 12

SAFETY FACTOR OF FIVE has been designed into this liquid petroleum filter and Fuelock by using impregnated aluminum die castings for the body, strainer cover and filter pack retainer ring. According to Century Gas Equipment Company, manufacturers of

the unit, the conversion from sand castings to die castings has saved the drilling of 10 holes, plus one milling and two lathe operations. Although designed to operate at 250 psi working pressure, the impregnated die castings have been passed by the Underwriters Laboratories which require a safety factor of five. According to their tests and Century's, the castings will withstand about 1750 psi pressure, at which point the steel screws elongate and allow a leak. Castings are produced by a jobbing die caster.

SOLDERING FIXTURES made of cemented carbides have shown great resistance to wear and deterioration at temperatures involved, and have been a key factor in assuring accuracy in the

silver soldering of band instrument key assemblies. In the Elkhart, Ind., plant of H. & A. Selmer, Inc., the uses of such carbides in place of stainless steel has solved critical production problems.

Besides resisting excessive oxidation, the use of carbide as jig elements has saved hours of hand filing and cleaning.

For Quality-Sure Die Castings

Westinghouse chose H-P-Ms

Westinghouse Portable Food Mixer. The upper and lower housing and internal gear case cover are all die cast on H-P-Ms.

One of several H-P-M 400-ton die casting machines at Westinghouse, Springfield, Massachusetts.

"To be sure" at Westinghouse, modern H-P-M die casting machines are used to produce mixer motor housings, vacuum cleaner housings and gear cases for one of the world's finest lines of electrical appliances. For example, the inside of this mixer motor housing has intricate detail, precision engineered to close tolerances. The outside is smooth and attractive without costly finishing operations. Die casting techniques using H-P-Ms assure the finest quality castings for the most discriminating user. Like many of today's modern manufacturers, Westinghouse depends on the most reliable machines to keep production lines running smoothly.

Have you investigated H-P-Ms for your die casting requirements?

Write today for Bulletin 5700. It tells the complete story on the complete H-P-M line.

THE HYDRAULIC PRESS MFG. CO.
Mount Gilead, Ohio, U.S.A.
A DIVISION OF KOEHRING COMPANY

HPM

1877—1957

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DATA OFFERED IN THIS MONTH'S ADS

the Reader Service Cards on the facing page will get you these free reference materials. Circle the numbers and mail.

1. **Casting Equipment**—More than 2,000 pieces of rebuilt casting equipment are described in an illustrated catalog from AAA Machinery & Equipment Co.

2. **Die Casting Supplies**—An illustrated bulletin from ACF Industries, Inc. describes their complete line of pots, castings, ingot molds, and goosenecks for the die casting industry.

6. **Non-ferrous Powders**—Complete details are available from The American Metal Co., Ltd. on their line of non-ferrous metal powders blended to specifications.

9. **1,000 Shots per Hour**—according to Bulletin A-10, an engineering report on small die casting machines from ABC Die Casting Machine Co.

10. **Investment Castings**—Complete information on the use of investment castings to solve design problems involving intricate shapes and unusual contours is offered by Arwood Precision Casting Corp.

12. **Plunger Rings**—Full details are available from The Auto-Diesel Piston Ring Co. on hardened steel plunger rings which last as long as 122 days, giving as many as 100,000 shots per set.

13. **Alloy Metal Powders**—The use of these powders in the fabrication of parts, and the properties of these parts, are covered in detailed reports from Alloy Metal Powders, Inc.

14. **13 Models**—of die casting machines are described in bulletins from B & T Machinery Co. Machines range in capacity from 100 to 750 tons — for zinc, aluminum, and brass.

15. **Sintered Powder Products**—A 24-page engineering handbook has been published by The Bunting Brass & Bronze Co., giving information on the composition, manufacture, and application of their sintered powder products.

16. **Sintered Steel Parts**—An informative "Quali-Sint" folder from Burgess-Norton Mfg. Co. describes their facilities and experience in the production of sintered steel parts.

18. **Powder Metal Press**—Specifications and complete details on a new 30-ton powder metal press are available from Hamilton Div., Baldwin-Lima-Hamilton.

19. **Safety Hydraulic Fluids**—Form 40134 from Carbide & Carbon Chemicals Co. describes fire resistance, anti-wear characteristics, and corrosion protection of their "CP"-type hydraulic fluids.

20. **Alloy Information**—A new bulletin from Cannon-Muskegon Corp. gives complete information on their vacuum-melted alloys of iron, nickel, cobalt, and special alloys.

21. **Die Casting Machines**—Eight die casting machine models with a variety of "bonus" features are described in a catalog from Cast-Master, Inc.

22. **Fire-resistant Lubricants**—Complete data is offered by Celanese Corp. of America on their "Cellulube" lubricants, which provide protection against excessive wear during continuous operation under extreme pressures.

25. **Bronze Bearings**—A new 52-page bronze bearing stock list offered by Chrysler Corp., Amplex Div. contains engineering data on more than 1,000 sleeve, flange, and thrust bearings.

26. **Die Casting Machine**—Bulletin 600 from The Cleveland Automatic Machine Co. describes their new model 600 die casting machine, built to deliver castings weighing up to 10 pounds in aluminum and 25 pounds in zinc.

27. **Vacuum Plating**—Complete information on coaters, lacquers, and methods used in vacuum plating is available from Consolidated Electrodynamics Corp., Rochester Div.

28. **Special Steels**—A publications catalog offered by Crucible Steel Co. of America lists information available on their stainless castings and other special steels.

32. **Die Cavity Sets**—A 12-page brochure from Detroit Mold Engineering Co. gives complete prices and specifications on six new standard sizes of cavity sets for die casting.

33. **Screw-In Thermometers**—Bulletin No. 5 from W. C. Dillon & Co., Inc. gives complete engineering data and price information on their dial thermometers which can be screwed into equipment or floated on liquids.

35. **Design Engineering Show**—Registration cards are now available for the 1957 Design Engineering Show and Conference scheduled for the New York Coliseum May 20-23.

36. **Saves $5,400**—Bulletin C-80 from Eclipse Fuel Engineering describes a double-chamber dry-hearth-type metal melter for aluminum. Advantages for both large and small operations are described.

37. **Metal Powders**—Specific information has been released by Easton Metal Powder Co., Inc. on their enlarged production facilities for metal powders of high quality and maximum physical properties.

39. **Shell Molding Data**—"59 Answers to Your Shell Molding Problems" is the title of a booklet offered by General Electric Co. Information is given on a wide variety of shell molding problems.

40. **Small Die Castings**—A fact-filled bulletin is offered by Gries Reproducer Corp. which explains their exclusive "Intercast" method of producing multiple-part zinc alloy units, with moving parts, in one automatic operation.

Continued on page 114

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- ☐ Permanent Mold Castings
- ☐ Plaster Mold Castings
- ☐ Shell Mold Castings
- ☐ None of these

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5	22	39	56	73	90	107	124	141	158	175	192	209	226	243	260	277	294
6	23	40	57	74	91	108	125	142	159	176	193	210	227	244	261	278	295
7	24	41	58	75	92	109	126	143	160	177	194	211	228	245	262	279	296
8	25	42	59	76	93	110	127	144	161	178	195	212	229	246	263	280	297
9	26	43	60	77	94	111	128	145	162	179	196	213	230	247	264	281	298
10	27	44	61	78	95	112	129	146	163	180	197	214	231	248	265	282	299
11	28	45	62	79	96	113	130	147	164	181	198	215	232	249	266	283	300
12	29	46	63	80	97	114	131	148	165	182	199	216	233	250	267	284	301
13	30	47	64	81	98	115	132	149	166	183	200	217	234	251	268	285	302
14	31	48	65	82	99	116	133	150	167	184	201	218	235	252	269	286	303
15	32	49	66	83	100	117	134	151	168	185	202	219	236	253	270	287	304
16	33	50	67	84	101	118	135	152	169	186	203	220	237	254	271	288	305
17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306

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4	21	38	55	72	89	106	123	140	157	174	191	208	225	242	259	276	293
5	22	39	56	73	90	107	124	141	158	175	192	209	226	243	260	277	294
6	23	40	57	74	91	108	125	142	159	176	193	210	227	244	261	278	295
7	24	41	58	75	92	109	126	143	160	177	194	211	228	245	262	279	296
8	25	42	59	76	93	110	127	144	161	178	195	212	229	246	263	280	297
9	26	43	60	77	94	111	128	145	162	179	196	213	230	247	264	281	298
10	27	44	61	78	95	112	129	146	163	180	197	214	231	248	265	282	299
11	28	45	62	79	96	113	130	147	164	181	198	215	232	249	266	283	300
12	29	46	63	80	97	114	131	148	165	182	199	216	233	250	267	284	301
13	30	47	64	81	98	115	132	149	166	183	200	217	234	251	268	285	302
14	31	48	65	82	99	116	133	150	167	184	201	218	235	252	269	286	303
15	32	49	66	83	100	117	134	151	168	185	202	219	236	253	270	287	304
16	33	50	67	84	101	118	135	152	169	186	203	220	237	254	271	288	305
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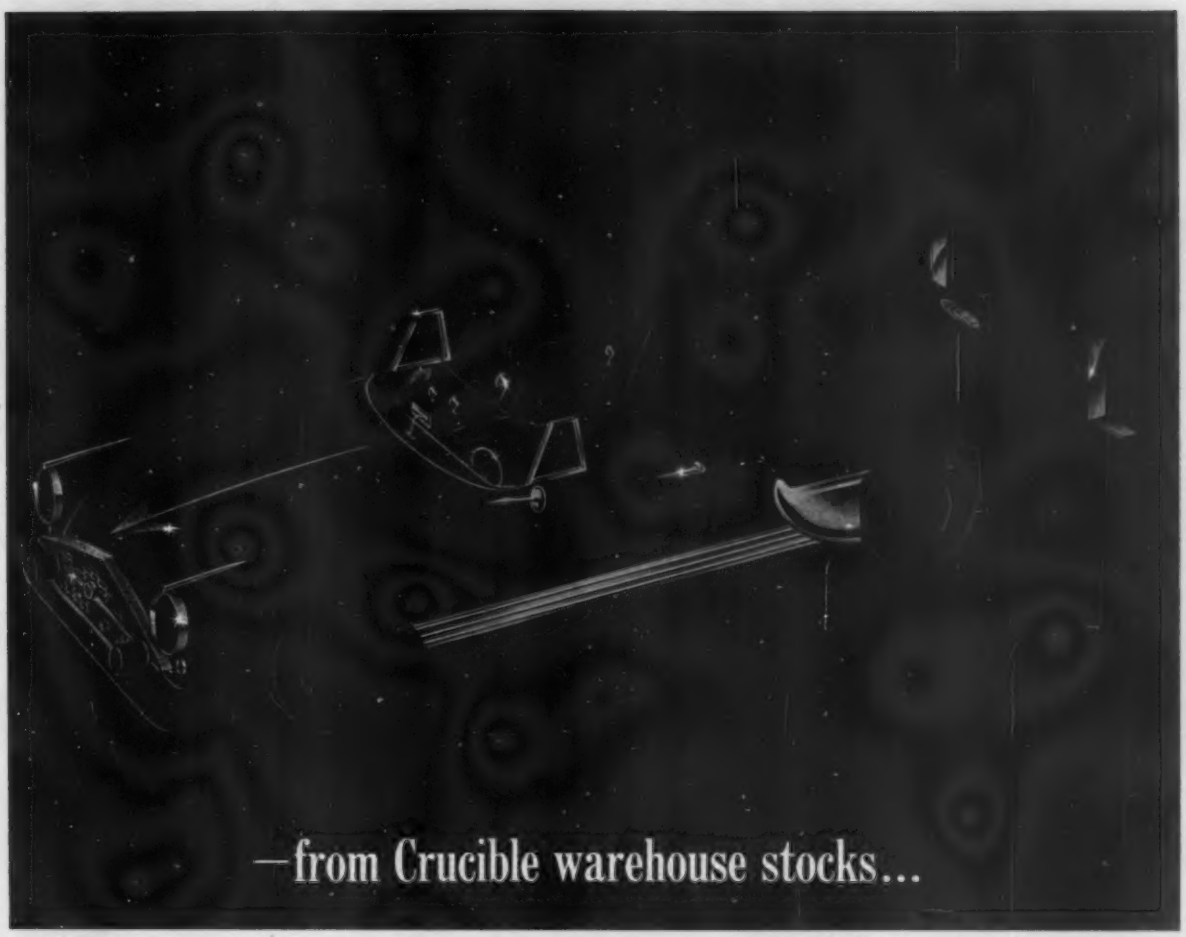

ultrasonically inspected CSM 2 DIE CASTING DIE STEEL

for auto trim

Like so many other automotive trim and hardware dies, Crucible CSM 2 was selected from warehouse stock for this long-run grill die. Built from a prehardened 25" x 15" bar, it produced 341,598 parts during the model year, and is now used for replacement parts.

Die by Valor Tool and Machine Co., Dearborn, Mich.

Like all Crucible die steels, it was ultrasonically inspected. This assures you of sound die steel quality — every time. It's a big reason why CSM 2 . . . and its partner for aluminum die casting, NU DIE V . . . are so popular that they're stocked in more than 430 sizes in Crucible warehouses from coast to coast. These sizes range from 1" to 40" wide . . . ¾" to 15" thick — and can be cut to your specifications at the warehouse.

For your die steel requirements — for holder blocks, solid dies, inserts or sleeves — you'll get *fast* delivery, sound quality from your local Crucible warehouse. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor — Railway & Power Engineering Corp., Ltd.

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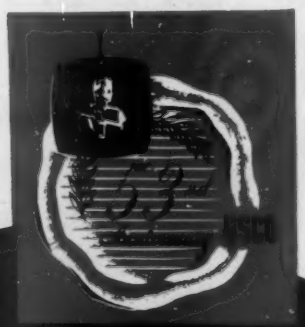
Z-5

USCO Z-3 (an aluminum-magnesium hardener) and USCO Z-5 (an aluminum-magnesium-copper hardener)—in either shot or ingot form—will give you manufacturing economies in producing your No. 3 and No. 5 Zinc Die-Casting alloys respectively, for hot metal delivery to your casting machines.

Analyses are carefully controlled so that your final alloy will conform to all existing governmental and society specifications. Our metallurgical engineers are available to discuss the exact use of USCO Z-3 and Z-5 hardeners with you. Write us for details!



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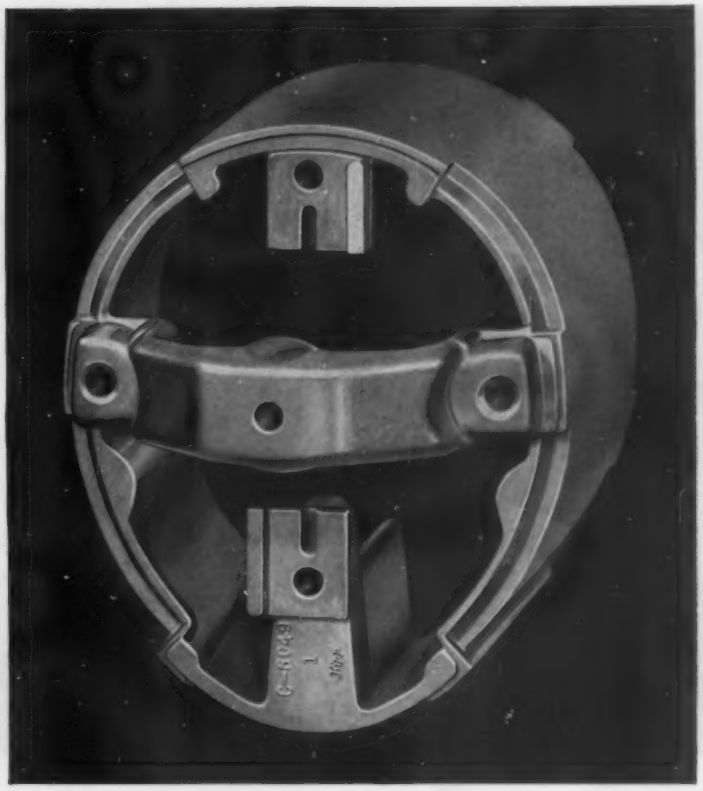
Full Process Utilization

. . . the telling factor



Thin sections, brackets, holes, bosses, counterbores and oval shape all produced in a split second—from molten metal. No other process can compete with this for eye appeal or low cost.

with MADISON-KIPP zinc and aluminum die castings

The Die Casting process has many advantages over other commonly used processes, but full process utilization requires the rare mechanical skills that are not only predominate but also seasoned, at Madison-Kipp.

This long-time experience in die casting has been of value to highly placed designers and engineers for over a quarter century.

Please clip this ad as a reminder to contact us when you have die casting requirements.

kipp

MADISON-KIPP CORPORATION
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Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

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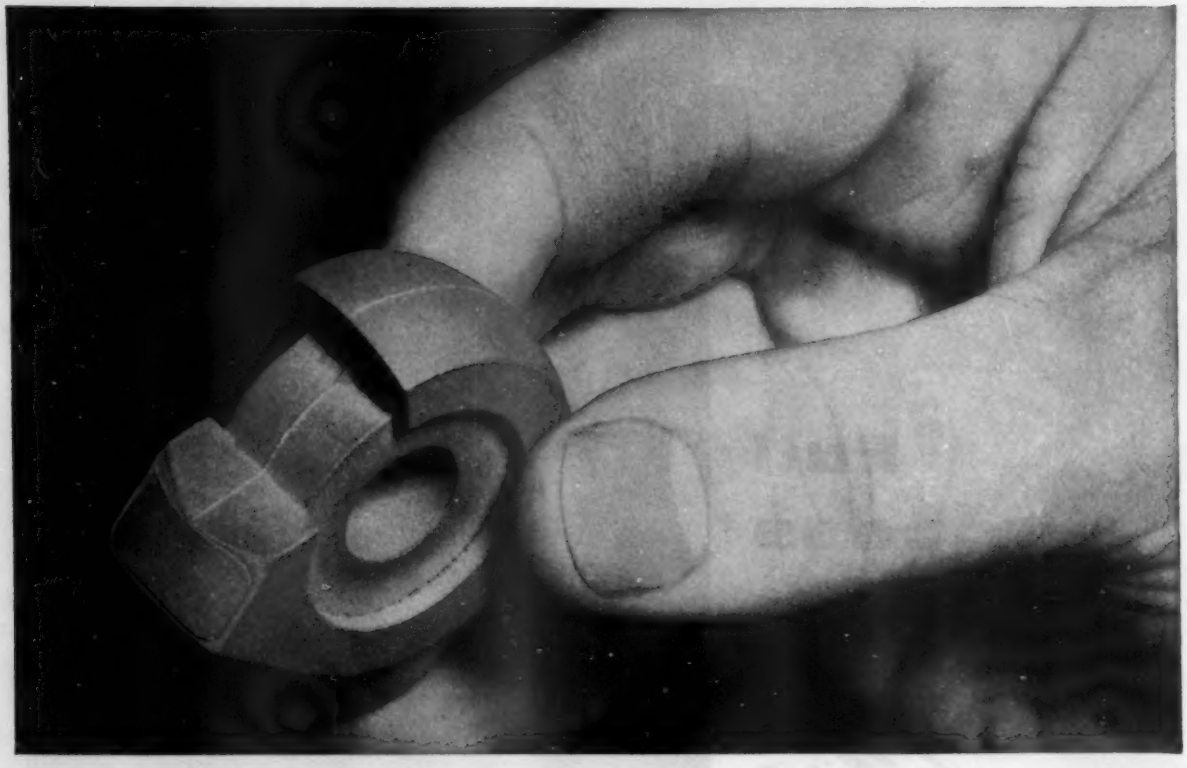

How precision casting cut costs 84%

on this small part

Camco, Inc., of Houston, Texas, specializes in oil field equipment.

They produce a gas lift valve which can be installed in, or removed from, an oil well without pulling the tubing.

Inside the valve is a latching cam to lock it in place. And that little part caused Camco expense and trouble — until they came to Inco.

The part had to be resistant to oil well corrosives — strong to take the pressures — hard so that it wouldn't gall, seize or change shape despite years of exposure to corrosion, abrasion, shock and pull.

One metal they tried was hard enough, but too brittle. And costs to machine the part from bar stock seemed out of line.

Camco, already using Inco Nickel Alloys — Monel* nickel-copper alloy and "K"* Monel age-hardenable nickel-copper alloy — for other parts of the valve with good results, decided to consult Inco on this one.

Inco engineers recommended precision investment castings in "S"* Monel hard-grade nickel-copper cast alloy.

The price of the finished cam, including the cost of drilling and lapping, cut Camco's cost on this part 84 per cent!

Can You Cut Costs with Inco Precision Castings?

Whenever you have a part which is 6 inches x 5 inches or smaller, weighs under 3 lbs., requires starting tolerances as close as plus or minus .005 inch per linear inch, and needs 5 or more fabrication steps, there's a good chance you can save by having it precision cast.

What Alloys Can Be Precision Cast?

You may obtain precision castings from Inco in many metals and alloys, from plain carbon steel to the new super alloys. And no matter what metal you specify, you get many advantages.

Seven Advantages of Precision Casting

Precision castings may save as much as 60 per cent of production costs. (Savings like Camco's are unusually high.) They also make possible the use of extremely hard metals. Reduce machine shop bottlenecks. Lead to economies through redesign. Reduce metal scrap. Often permit the use of a higher alloy which otherwise would be too costly. Even make possible designs you previously thought impractical to produce.

*Registered Trademark

Get This Helpful New Booklet

Trying to keep costs in line on some small part? Then write for new 16-page booklet, "Cast to Outlast." Contains many case histories detailing how others cut costs with Inco precision castings. There is a good chance this helpful data will suggest a practical way to cut your costs, too.

The International Nickel Company, Inc.
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Inco Castings

. . . Precision, Sand, Centrifugal

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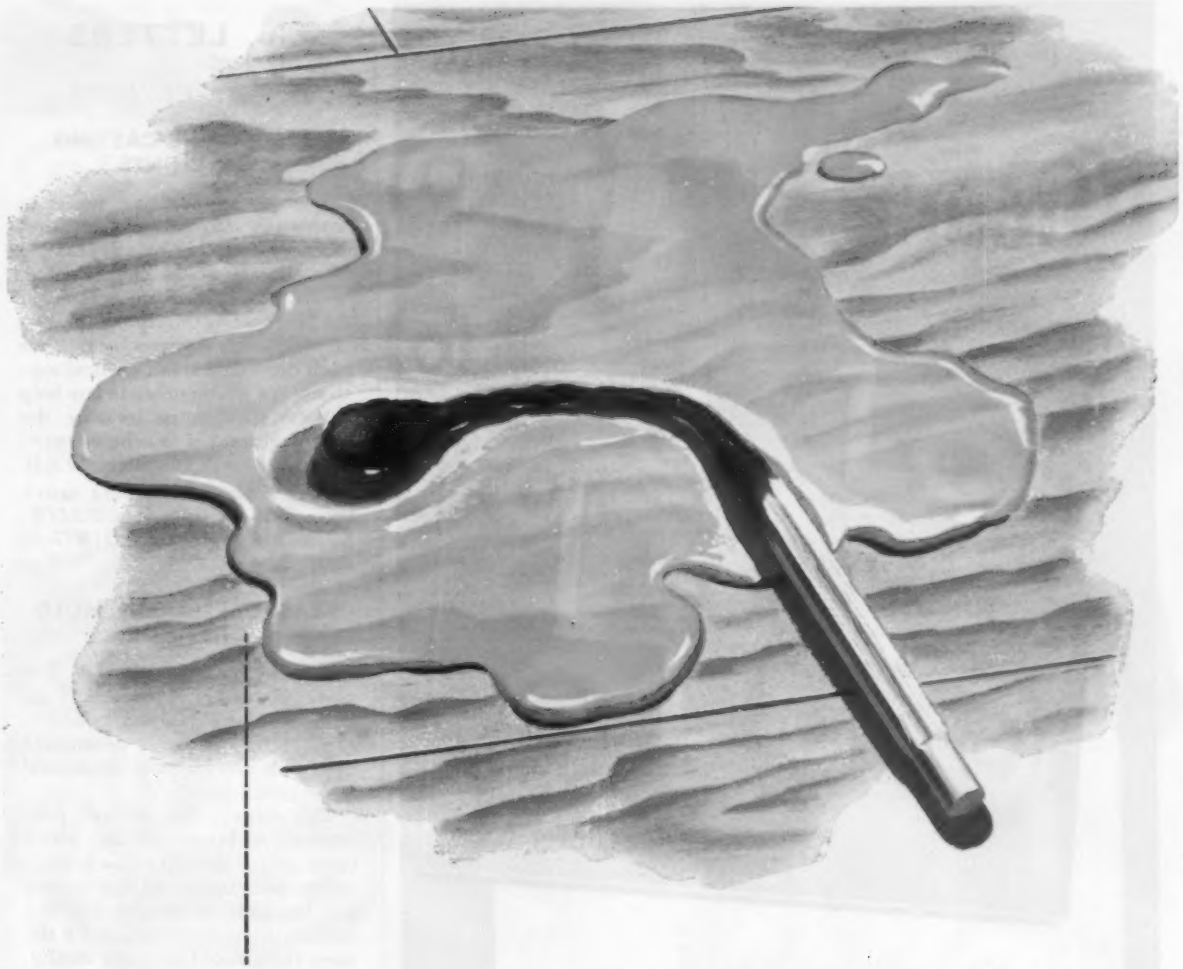

An economical hydraulic fluid that actually snuffs out fire!

WHEREVER a fire hazard exists near a hydraulic system, you can greatly reduce this hazard without excessive costs by specifying Shell Irus Fluid 902. This new hydraulic fluid is a "snuffer" type fluid with water dispersed in oil.

Because Irus* Fluid 902 is economical, many plant operators have found they save thousands of dollars yearly when the changeover is made. And they obtain performance which is unsurpassed by much higher priced fire-resistant fluids.

For complete information on Shell Irus Fluid 902 write to Shell Oil Company, 50 West 50th Street, New York 20, N. Y., or 100 Bush Street, San Francisco 6, California.

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UCON Hydrolubes
spell
SAFETY
This new booklet . . .
. . . tells you how CARBIDE's UCON Brand hydrolubes spell safety for you, your plant, and your employees.
Yes, industrial experience over a period of more than 10 years has shown that the common fire hazards connected with hydraulic operations are eliminated when UCON hydrolubes are used. So, why not find out how the fire-resistance, outstanding anti-wear characteristics, and corrosion protection of new and improved UCON hydrolube "CP"-type fluids can help spell safety for you. Write for "Ucon Hydrolubes Spell Safety," Form 40134.
CARBIDE
CARBIDE AND CARBON CHEMICALS COMPANY
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LETTERS

the readers' forum

SPECIAL DIE CASTING MACHINES

I attach an abrasive wheel in which the knurled steel mandrel has been anchored by a die casting method. We would like to get in touch with the manufacturer of the die casting machines for this class of work. Apparently this has been done on a small vertical machine. We will appreciate any help you can give us in locating the manufacturer of machines suitable for this application. W.E.B.

Machines to do this work were first described in PRECISION METAL MOLDING in April, 1956.—Ed.

BRASS PERMANENT MOLD CASTINGS

A local manufacturer of fire place fixtures has approached me with the idea of pouring brass ornamental castings in permanent molds. Is this possible, or should I say practicable?

This concern has, in their possession, a brass casting which came from Japan. It has a beautiful as-cast finish and has caused this company to wonder if it is a permanent mold casting and if the same thing could be made locally.

Thanking you for any information you may have. J.A.W.

The manufacture of brass permanent mold castings is a standard procedure with many foundries. Some information on sources of such parts has been forwarded to J.A.W.—Ed.

WHOSE RESPONSIBILITY

We would appreciate it if, as a reader service, you would send us any information you have pertaining to where the Mold Maker's responsibility ends and just what the Molder's responsibility is in the successful operation of a mold. H.L.H., Jr.

Frankly we have not been able to find any unanimity of opinion on this subject. Among mold and die makers and users with whom we talked the consensus seems to be that beyond following plans and specifications, any added responsibility of the mold maker is a matter of individual agreement. We would like to have the opinions of the readers.—Ed.

One of these Monarch casting methods offers you

MORE CASTING VALUE PER DOLLAR

When you check Monarch's non-competitive casting analysis, every phase of production, including machining, finishing and assembly, is properly evaluated. Monarch mass-produces castings by all three methods, with more than 20 years experience. Monarch operates the largest finishing department of any commercial foundry. This broad manufacturing experience assures you "non-competitive", unbiased answers to the manufacturing problems of your end-product—and more casting value per dollar. Consult Monarch today for improving end-product performance at lower factual end-cost.

- *Aluminum permanent mold fry-pan, cast in heating element, colorful Spectraglaze® porcelain enamel finish.*
- *Certified zinc electronic housing, as cast, commercial trimmed.*
- *Aluminum die cast portable tool, mar-resistant Velvaglaze® finish.*

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PIONEERS IN CASTING PROGRESS

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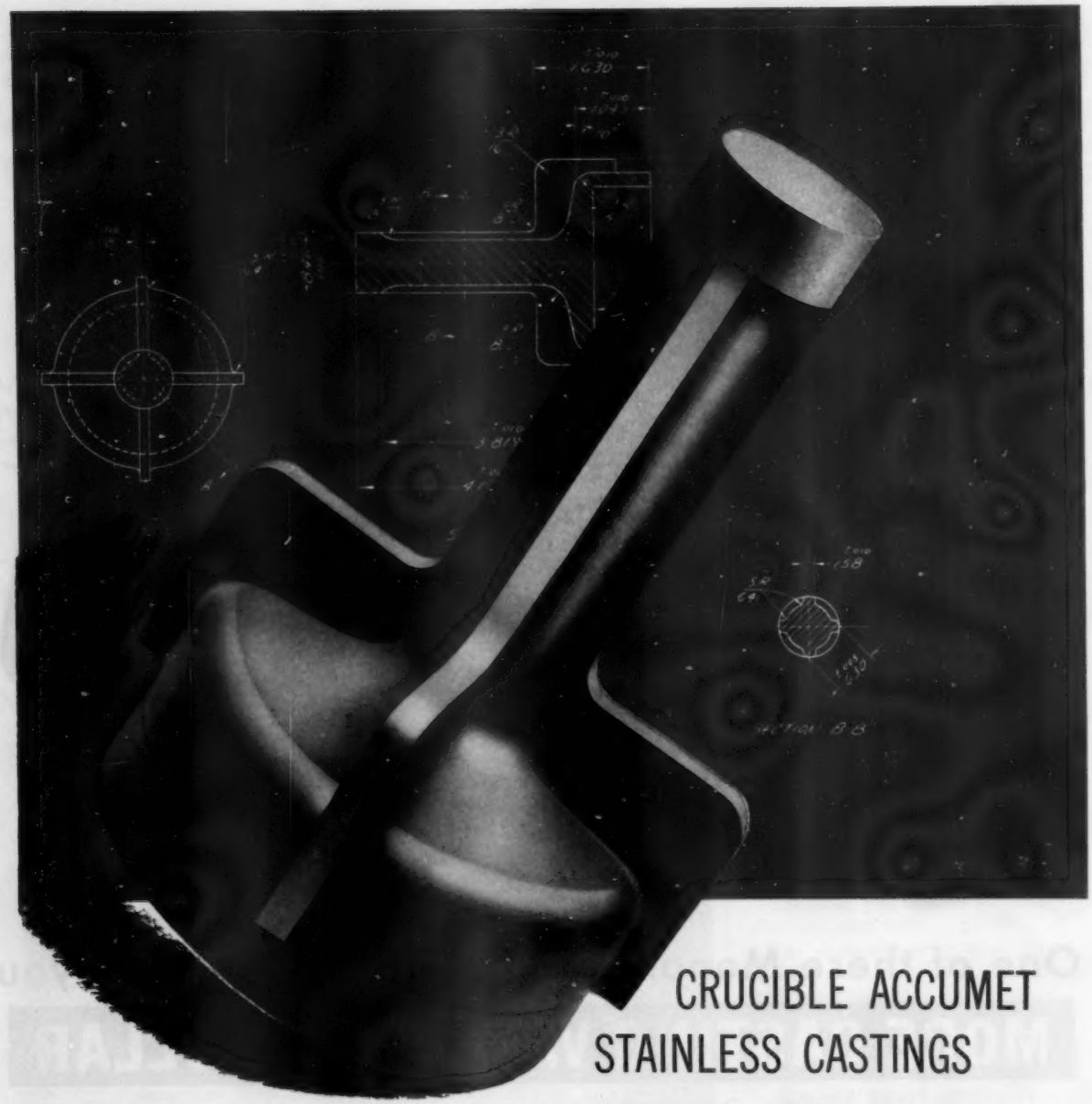

CRUCIBLE ACCUMET STAINLESS CASTINGS

provide smoother surfaces . . . closer tolerances — cut finishing costs

Even intricately shaped parts, like this cream separator neck piece, can be used essentially as-cast when produced by the ACCUMET method. That's because ACCUMET casting employs hot molds with special inner linings. You get castings on which thin sections are minutely defined . . . and with exceptionally fine surface finish. *Costly finishing operations are practically eliminated.*

On this stainless steel part, for example, the only finishing operations necessary are drilling and tapping of the stem section, grinding flats on the bow end, and polishing.

To minimize finishing operations on your products, consider the advantages of ACCUMET precision investment castings. Let your Crucible representative show you how their close tolerances, fine finish, and physical and metallurgical accuracy can spell substantial savings for you. And — to see what information is available on these and other Crucible special steels, write for your free copy of the "Crucible Publication Catalog." *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

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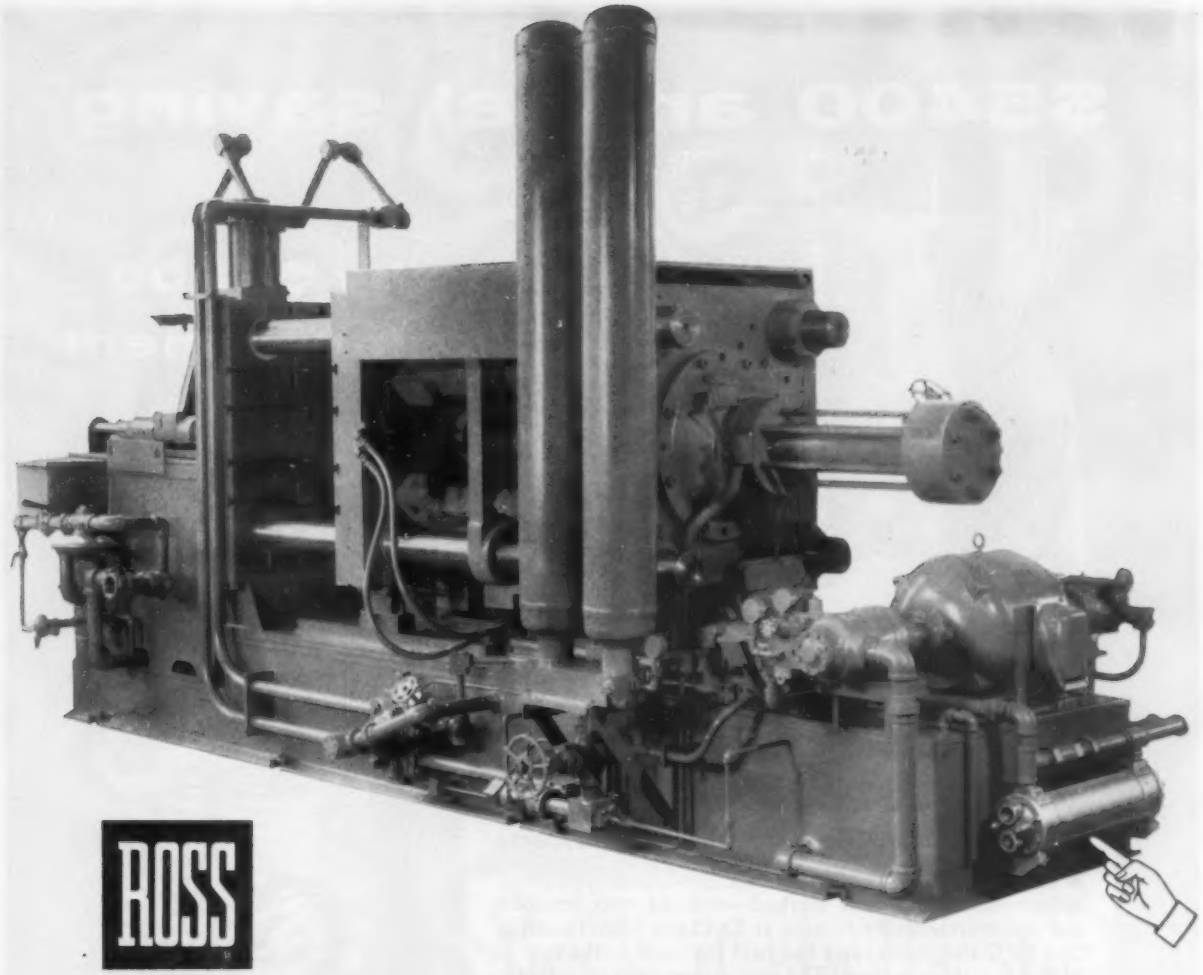

ROSS

ROSS EXCHANGER'S oil cooling efficiency harnesses full power of this B&T Die Casting Machine

Cycling up to 625 shots per hour, this B&T Die Casting Machine with 600 ton locking pressure turns out strong, dense castings of zinc, aluminum, magnesium and brass. With machines of this type, correct hydraulic temperature is vital to efficient performance.

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Completely pre-engineered and fully standardized, Ross Exchangers are stocked in a wide range of sizes to meet your heat transfer requirements.

For more details, request Bulletin 1.1K5. Ross Heat Exchanger Division of American-Standard, Buffalo 5, N.Y. In Canada: American-Standard Products (Canada) Limited, Toronto 5, Ont.

ROSS HEAT EXCHANGER

Division of AMERICAN-Standard

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$5400 annual saving

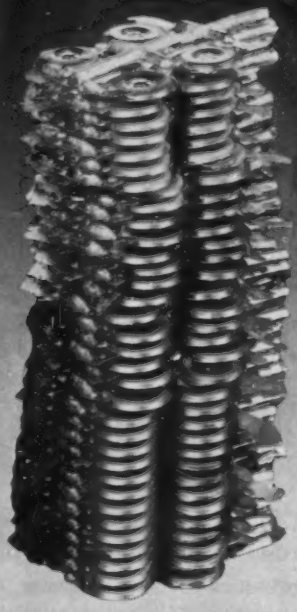
by $4200 investment in ECLIPSE FURNACE

New Double-Chamber Dry-Hearth-Type Metal Melter Proves Flexibility in Small Shop

Increases Production . . . Eliminates Rejects

● The new Eclipse double-chamber dry-hearth-type metal melter—actually a new method—replaced two crucibles and one reverberatory furnace at Le Claire Manufacturing Co., Le Claire, Iowa, and has paid for itself at the rate of $450 a month in savings! The new melter combines advantages of Eclipse direct firing with the first truly separate melting and holding chambers. At Le Claire, the one dry-hearth melter has made this remarkable record supplying all metal for the plant's sand- and die-cast aluminum casting operations. Castings for power mowers, electric and gas motors, as well as many others, are cast from this one furnace. Actually designed for high-production operation, the melter gives even better results in larger foundries.

Pigs are melted on a steep sloping hearth which gives fast run-off of molten metal to the holding chamber. Gassing and agitation of the metal in holding chamber are eliminated because no cold metal enters the bath. Direct firing permits faster, more efficient heating, requires less fuel. All moisture is driven off while metal is melting . . . all oxide inclusions are deposited on surface of hearth where they are easily removed by raking. Hearth and holding chamber are separately heated and controlled for ideal melting and pouring temperatures. And there are more additional quality-improving and cost-saving advantages for your *large or small* operation than can even be suggested here! Write *today* for . . .



Bulletin C-80 →

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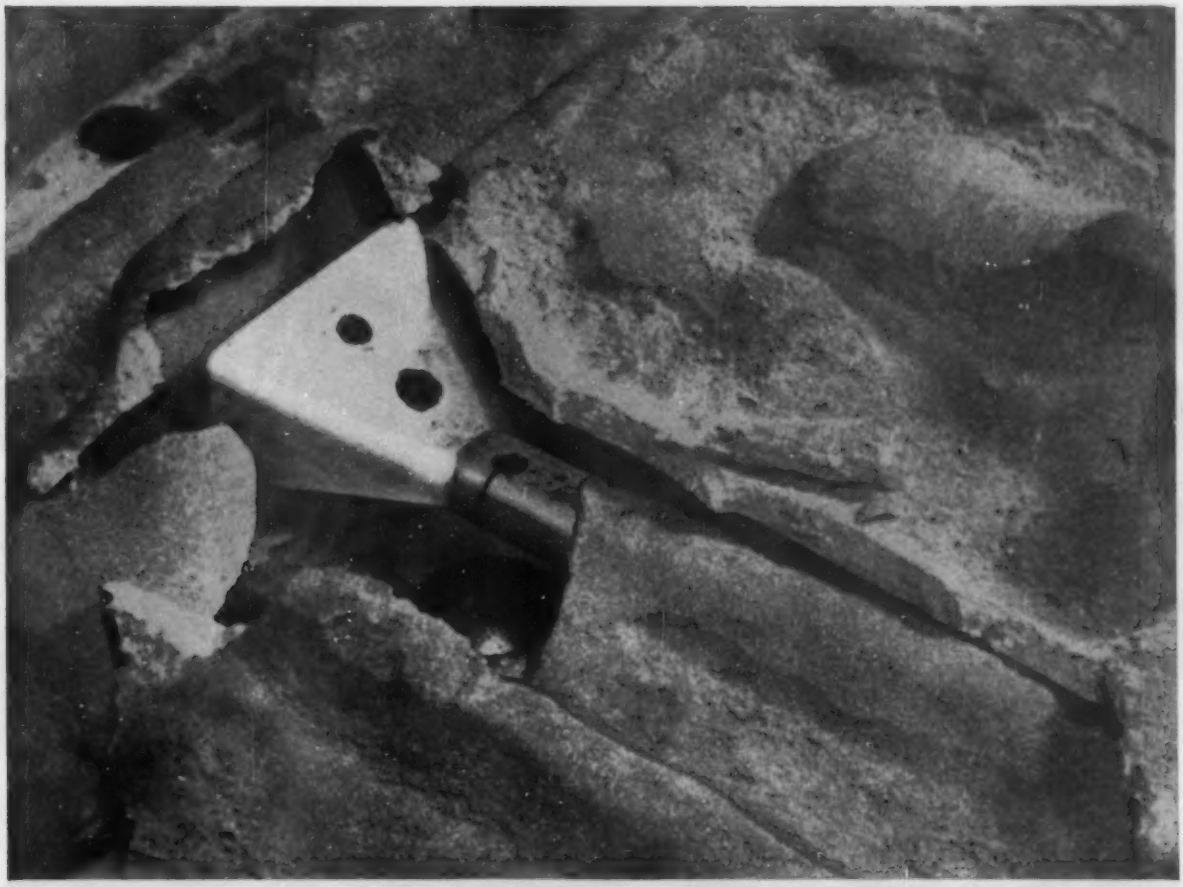

9 things to check if shells stick

You can profit most from the inherent advantages of shell molding—close tolerances, smooth surfaces and reduced labor costs, if you have the latest technical information on shell mold and core making techniques. Here's where General Electric's technical service and technical literature can help.

For example, G.E.'s *"59 Answers to Your Shell Molding Problems"* tells you nine things to look for when shells stick . . . and what to do about them. Here, too, you'll find answers to other shell molding problems you may have encountered.

And when it comes to shell molding resins, G.E. has a range of products, each designed to help you make better shell molds and cores for the job at hand. *G-E 12374*, fast curing resin for high speed production, minimizes warpage because of its "hot rigidity." *G-E 12368* is best for intricate patterns with deep draw and minimum draft. *G-E 12392* is a good general purpose resin. It has no tendency to peel; properties of build-up and release are good. *G-E 12316* shell bonding resin joins shell mold halves efficiently, and *G-E SM-55* silicone release agent gives quick, clean removal of shells from the pattern.

For a copy of "59 Answers . . .", or for other technical information, write General Electric Company, Section PM-2, Chemical Materials Department, Pittsfield, Mass.

IF SHELLS STICK . . .

• Check pattern for undercuts or rough spots • Be sure new patterns are thoroughly conditioned • Polish and recondition abraded patterns • Use proper lubricant • Avoid excessive lubrication • Clean pattern thoroughly • Use slower curing resin • Check ejection pin platen level • Look for loose pattern pieces.

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60,000 square feet of complete, modern die casting facilities

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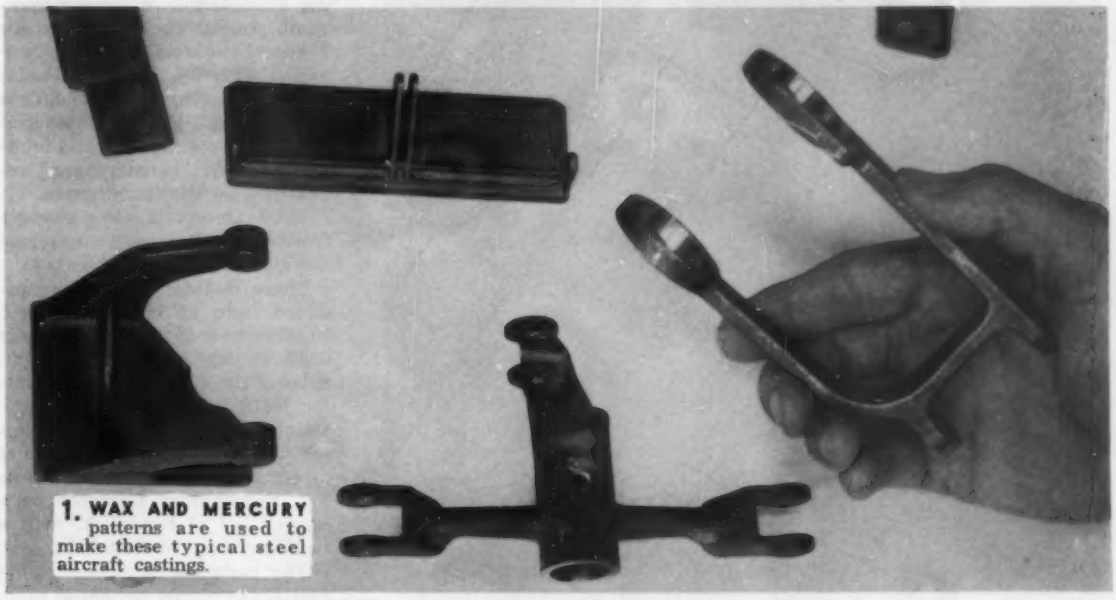
NEW ENGLAND DIE CASTING CO., WEST HAVEN, CONN.

MORE STEEL CASTINGS CAN BE USED IN AIRCRAFT



1. WAX AND MERCURY patterns are used to make these typical steel aircraft castings.

Investment castings cut costs while giving . . .

High Strength/Weight Ratio In Aircraft Parts

By J. F. MOORE, Supervisor
Raw Material Buying, Rohr Aircraft Corp.

THE rigid demands placed upon aircraft by the thermal barrier compels the industry to seek, in all possible haste, better materials and better methods of fabrication.

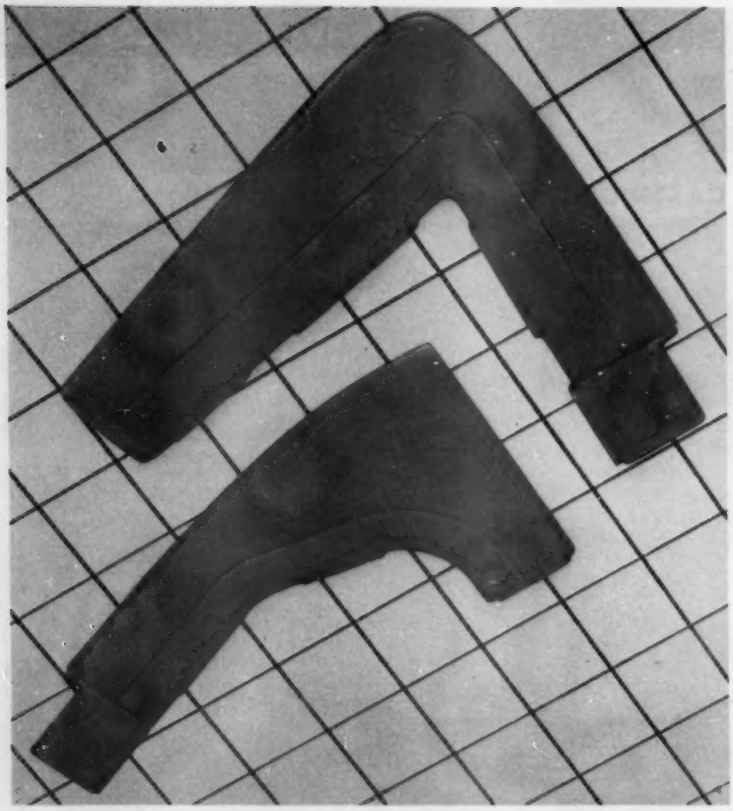
Procuring uniformly high quality steel alloy castings for aircraft assemblies traditionally has been an irritating dilemma. Within the past six or seven years, and particularly at present, investment castings for certain small, complicated parts and assemblies offer decided cost and quality advantages.

Why are aircraft castings difficult? To begin with few parts have flat, plane surfaces. Most configurations have curves and, to complicate their manufacture, compound curves. A further restriction that goes to increase manufacturing costs is that all parts, large and small, must be held to strict dimensional tolerances. Finally the ever present problem of holding weight down requires that the materials used must have a high strength/weight ratio. For many applications, particularly on high altitude, high speed airplanes, thin sectioned steel castings hardened to an ultimate tensile strength of 180,000 to 200,000 psi have proven to be the most economical.

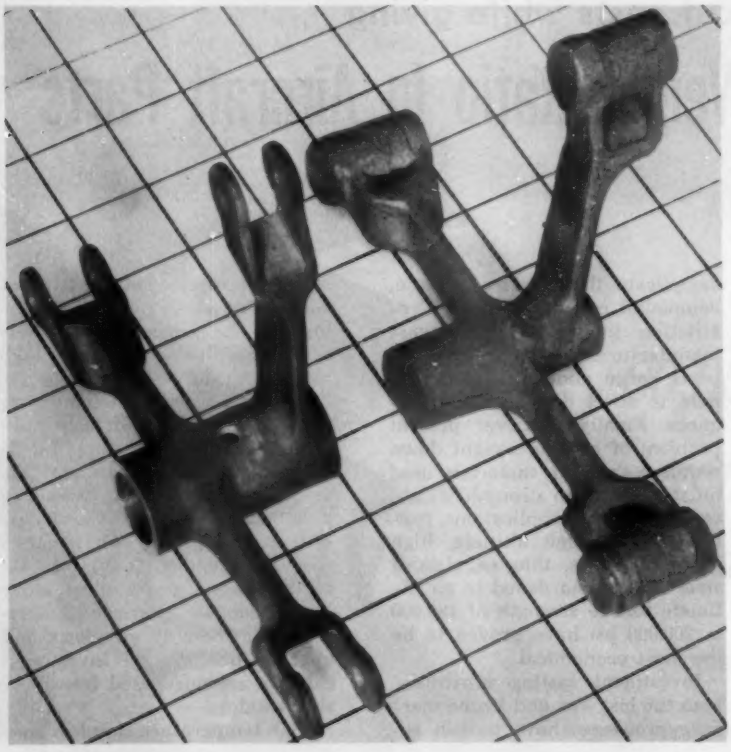
Investment casting methods, both the lost wax and frozen mercury processes, have proven superior for specific small parts and assemblies where machine finishing could be reduced, while maintaining hairline accuracy and high metallurgical standards.

Consistent with the industry practice, Rohr Aircraft now purchases investment castings for 35 different precision parts and assemblies. The trend is toward a greater number. In some instances, the prime contractors specify investment castings for subcontracted projects; in other cases, company purchasing recommends them to cut costs and upgrade quality. All investment castings are purchased from outside vendors.

High temperature stainless steel



2. REPLACING SAND CASTINGS, these steel boomerangs are cast virtually to the final dimensions required. The saving — several hundred percent.



3. CAST-IN CLEVISES now instead of costly machining. This is only one of the several savings in this part made possible by converting to investment castings made with frozen mercury patterns.

honeycomb sandwich structures are produced as straight, tapered, curved and compound contoured. These panels are applied to wings, control surfaces and similar installations. Two small angular castings are brazed into the leading edge airfoil of some honeycomb panels. These castings, see Figure 2. measure about 6¼" x 3" and 5½" x 5¼" respectively. Their shape led to the nickname "boomerang." Attempts to produce these castings by sand foundry methods "boomeranged" repeatedly on the foundrymen.

Investment casting using a frozen mercury pattern solved the manufacturing problems.

These castings had to be produced from an engineering loft, in order to hold a net tolerance of 0.003. A skin step is cast on both sides of the curved, tapered angle for 0.010 inch thick, type 17-7, stainless steel face sheet. This whistle-thin requirement comes off accurately via investment casting. Boomerangs formerly were hogged out of bar stock, with a resultant cost of $400.00. apiece. Better parts are now made as investment castings for $74.00 each, and costs are declining as production know-how improves.

Another interesting before and after story is that of a small bellcrank casting shown in Figure 3. This is a lever part for an airplane propeller control system. Investment casting of the part eliminated awkward masses which formerly required extensive machining on sand castings to provide holes and clevises. Three clevises are cast into the 17-4 stainless steel investment casting. A ¾ inch diameter hole for the pivot shaft also is cast, leaving just enough extra stock for reaming. While machining has been greatly reduced, most important is that the bellcrank as an investment casting meets all stress and tolerance requirements. Rejects are very limited now, while the obsolete sand-molded version had a high rejection rate due to hot tears in the 4130 alloy in which the part was cast. Ac-

cording to the inspectors, "recovery rates with sand castings were distressingly unpredictable."

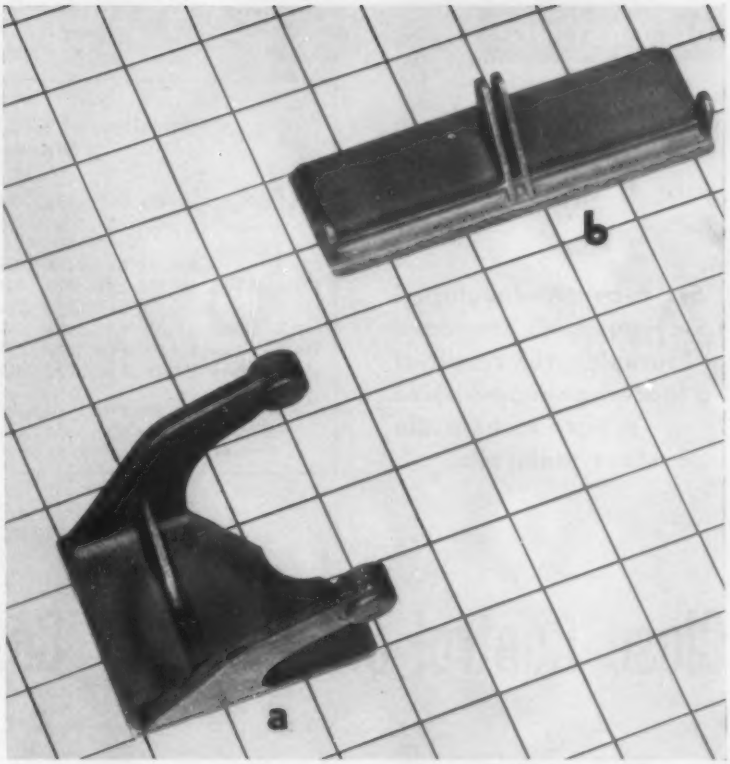
A bracket assembly, idling arm support, for a propeller control system, shown in Figure 4a, presented the dual problem of holding tolerance while reducing strength. This casting, in 410 stainless steel, comes out of the mold at a maximum tensile strength of 210,000 psi. At the hardness accompanying this strength, the casting is too brittle for the desired functional role. Annealing, or normalizing, is necessary to meet the operational requirements. Careful foundry control afforded by investment casting minimized the problem so that the part is delivered with an ultimate tensile strength of 180,000 psi. Six bosses, in obtuse positions on the casting, are easily faced, scribed and drilled.

Two Other Processes

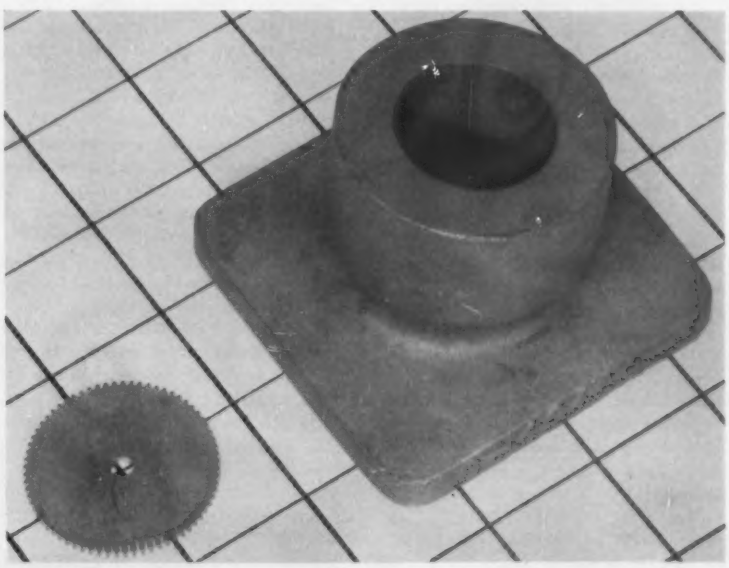
Investment casting specialists have become so adept at turning out precision aircraft parts that an accumulative scale of ± 0.005 per inch is guaranteed. For instance, a casting which is 5 inches at its greatest dimension will be held to a tolerance as close as 0.025. Such control has been demonstrated time after time. One such part is a thin 5" x 1½" louvre casting shown in Figure 4b. Flap recesses are cast on both sides of the ultra-thin part, together with two tiny pin ears and a difficult angular clevis. Forty of these castings comprise a shutter assembly for an air ducting system on a plane. Investment casting is so accurate that even tiny pin holes through the ears and clevis are cast. The only finishing is touch-grinding at the ends.

Currently, Rohr Aircraft is exploring two other precision methods of fabrication. A connector flange, shown in Figure 5, is part of the water injection system on a jet bomber. This flange is attached to a flared tube. This small, though rugged, casting has been made satisfactorily by the shell molding process.

The other part shown in Figure 5 is a small cogged gear about the size of a 50 cent piece. This gear is made by powder metallurgical methods and, while not yet in use, gives promise of still another cost saving production method.



4. ULTRA-THIN PARTS and complex shapes lend themselves nicely to investment casting as a production method. Frozen mercury patterns allow the casting of larger pieces. This is called the Mercast Process.



5. UNDER STUDY for probable production are parts made by two other precision molding processes. The gear is made from metal powders and the flange is cast in a shell mold.

Six recently-developed spectrographic standard samples, the result of a four-year cooperative program, help die casters maintain . . .

TABLE 1.
Composition of NBS Zinc-Base Spectrographic Standard Samples.

NBS No.	Designation 1/ 2/	Cu %	Al %	Mg %	Fe %	Pb %	Cd %	Sn %	Cr %	Mn %	Ni %	Si %
625	Zinc-Base A	0.035	3.06	0.070	0.035	0.0014	0.0006	0.0005	0.013	0.031	0.019	0.018
626	Zinc-Base B	.055	3.57	.020	.105	.0021	.0014	.0011	.039	.048	.048	.042
627	Zinc-Base C	.135	3.89	.030	.023	.0082	.0049	.0042	.004	.014	.003	.024
628	Zinc-Base D	.61	4.61	.009	.066	.0044	.0041	.0017	.009	.009	.030	.009
629	Zinc-Base E	1.50	5.16	.094	.016	.013	.015	.012	.0008	.002	.008	.078
630	Zinc-Base F	0.98	4.30	.030	.022	.0083	.0048	.0040	.003	.011	.003	.023

1/ Size: Bar segments, 1¾ in. square and ¾ in. thick.
2/ NBS Nos. 625, 626, and 627 correspond to ASTM Alloy AG40A; NBS Nos. 628, 629, and 630 correspond to ASTM Alloy AC41A.

Close Control of Zinc Alloy Composition

SIX new spectrographic standard samples of zinc-base alloys are now available from the National Bureau of Standards. Carefully analyzed and certified as to composition, the new standards are designed for calibrating and checking spectrochemical methods in the analysis of two important zinc-base die-casting alloys (ASTM designations AG40A and AC41A).

For each of the two alloys, three standards have been issued to provide the necessary composition ranges for the elements covered by specifications; namely, aluminum, copper, magnesium, iron, lead, cadmium, and tin. The standards also contain useful concentration ranges for chromium, manganese, nickel, and silicon.

In recent years, high-speed spectrochemical methods of analysis have been extensively adopted by both producers and consumers of metal products. In each field of application, these newer techniques have brought about a need for standard samples for calibration purposes.

Several years ago it became apparent that spectrographic standards of accurately determined composition and high homogeneity were urgently needed in the zinc die casting industries. On learning late in 1952 that the General Motors Corporation intended to prepare a series of zinc-base standards for use within the Corporation, the Bureau proposed that the program be expanded to provide nationally available standards for the alloys.

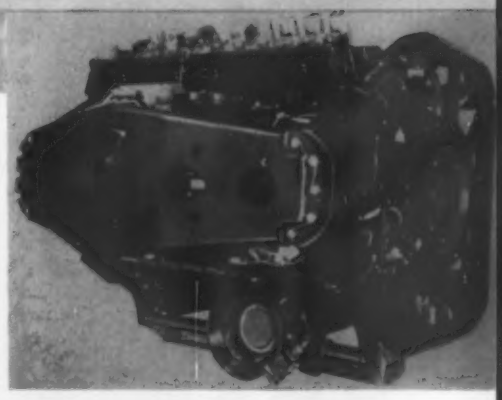
The cooperative program which was adopted followed a pattern of similar programs in the past, but was unique with respect to the close cooperation in all phases of the work from the planning through the final analytical stage for certification.

The zinc-base standard samples are available as bar segments 1¾ in. square and ¾ inch thick. In this form the sample serves as a self electrode in opposition to a high-purity graphite electrode for electrical excitation in spectrographic analysis. The material was melted and chill-cast into bars by a special continuous casting process at the Chicago Branch of the National Lead Company.

The homogeneity of the standard materials was investigated both at NBS and at General Motors Corporation. The Bureau used spectrochemical methods while General Motors employed both chemical and spectrochemical techniques. The results showed that the standards exhibit satisfactory homogeneity for the specified portion of each sample, that is, the portion included between 3/16 in. and 11/16 in. from each side of the square section of the sample. (The center core, ⅜ in. square, and a layer at the periphery, 3/16 in. thick, are portions that may differ in composition from the certified portion for some elements).

Chemical analyses on millings representing the certified portion of the bars were made by six cooperating laboratories: Apex Smelting Co.; General Motors Corp. (Research Division); Hudson Bay Mining and Smelting Co., Limited; Metal and Thermit Corp.; New Jersey Zinc Co.; and NBS.

The zinc-base standards may be obtained from the National Bureau of Standards for a fee of $8.00 each. A provisional certificate supplied with the standards gives average values of the analyses reported by the co-operating laboratories. The compositions of the standards are given in Table 1.



1. CAST COMPONENTS used on aerial refueling equipment help to reduce spillage to a teaspoonfull when disconnect is accomplished while transfering fuel at 600 gallons per minute. Inset shows tanker plane refueling unit.

Mastery of the air depends on . . .

Precise And Economical Forming Of Metals

By SAMUEL BISHOP, Metallurgist
Flight Refueling, Inc.

THE first successful inflight refueling was made by Smith and Richter in June, 1923, above San Diego, California. At that time, plane to plane fuel transfer was hazardous in the extreme and often resulted in liberally "dousing" the receiver plane and its pilot. Flight speeds were slow and altitudes low in the early days so that almost all conditions were unfavorable for fuel transfer between light planes.

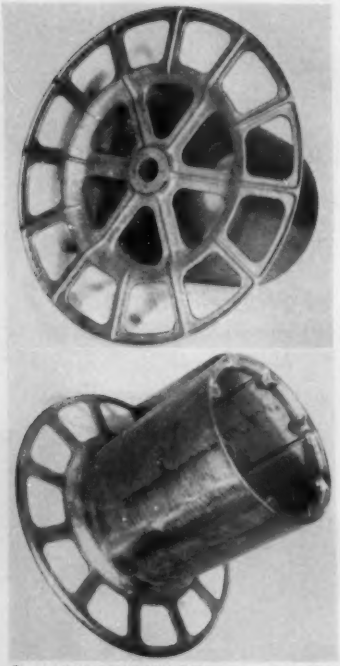
Today, with far larger, faster planes flying at high speeds and at high altitudes and on automatic pilot to help maintain a steady state, the transfer of fuel is much more readily done.

Along with the changes in airplanes, there has come enormous improvements in the equipment used for aerial refueling. But the demands, particularly of the military, for ever decreasing weight so that greater fuel loads or greater "pay" loads can be carried have forced the design engineers to exercise maximum ingenuity to stay within both the weight and strength specifications.

To secure the most favorable strength/weight ratio, the light metals are used wherever possible and the fabricating methods employed are those that will give the highest ratio at the lowest final cost. Within the permissable usage of the light metals, the various casting processes are assuming increasing importance: the most spectacular gains have been shown by the permanent mold casting method.

The most cogent reason for the increased importance of permanent mold castings in aircraft components is the capability of the process to cast strong, thin-walled radiographically sound parts. In many cases, these castings require little or no machining to ready them for final use. When major machining is required, the scrap losses due to casting defects are negligible.

Light metal permanent mold castings have other important characteristics for aircraft use. They are easily and economically machined, they are inherently, or are easily made, resistant to severe corrosive atmospheres and extremely complex coring can be done through the use of metal, sand or plaster cores or any combination of these. The hose reel drum used on several models of flight refueling equipment made



2. ALMOST FINISHED as-cast, this hose reel drum needs but minor machining to be ready for use.

TABLE 1. COMPOSITION AND PROPERTIES OF ALLOY AZ91

Composition:			
Aluminum	8.9 to 9.3%		
Manganese	0.13 min.		
Zinc	0.4 to 1.0		
Silicon	0.3 max.		
Copper	0.10 max.		
Nickel	0.01 max.		
Other Impurities	0.30 total		
Magnesium	balance		
Physical Constants:			
Specific Gravtiy	1.81 g/cc		
Density	0.066 lb./cu. in.		
Coefficient of Thermal Expansion	1120°F		
65 to 212°F	0.000014 in./in./deg.F		
65 to 750°F	0.000016 in./in./deg.F		
Thermal Conductivity	0.16 CGS units		
Electrical Resistivity	17.0 microhm-cm.		
Specific Heat	0.249 cal/g/deg.C.		
Modulus of Elasticity	6,500,000 psi		
Modulus of Rigidity	2,500,000 psi		
Typical Mechanical Properties:	F	T4	T6
Tensile Strength, psi	24,000	40,000	40,000
Yield Strength, psi (0.2%)	14,000	14,000	19,000
Elongation, % in 2"	2	11	4
Brinell Hardness 500 kg.	52	53	66

(Note: F — as cast, T4 — solution heat treated, T6 — solution heat treated and aged at 335°F for 16 hours.)

by Flight Refueling, Inc. shows how almost all of these desirable properties of light metal permanent mold castings are utilized. These refueling devices are built for both the Army and Navy, a complete tanker plane unit ready for installation in a KB-50 plane is shown in the insert of Figure 1.

The hose reel drum for one of these units is shown in Figure 2. This part, a magnesium permanent mold casting, is made by H. & S. Metal Products of Los Angeles, California.

Material

The drum is cast in magnesium alloy AZ91 (QQ-M-56) and is age hardened to Rockwell E 72 minimum. The composition, physical and mechanical properties are given in Table I.

Size

The drum is 16" in diameter and is about 17" long. The end flange is 28¾" in diameter and the overall length of the unit is 18⅞". The weight of the casting, as trimmed, is only 17 lbs.

Section Thickness

On the drum, the wall thickness away from the stiffening ribs is 5/6" and six ribs, cast integrally, extend the full length of the drum and are carried along the inside of the spokes that radiate from the hub. These ribs are ⅜" wide and 7/16" high, rounded on the top. The flange has twelve supporting spokes, six that are continuations of those from the hub and six equally spaced between them. The spokes are all ribbed on the outer face as shown.

Weight Savers

Wherever possible, weight savers have been used. This is noticeable on the flange where an open web type of construction is used and on the opposite end where cast pads replace a continuous ring for bolt holes.

Machining

There is so little machining needed on this hose drum that only one pound of metal is removed. Further, all of the machining operations are relatively simple. On the end that does not carry a flange, a cut is taken to provide a close fitting rim for the second flange. This rim and the bore of the hub are the only places on the reel that require appreciable machining. The diameter here is machined to a tolerance of +0.005 −0.000 and the depth of the rim is machined to give a reference length within ±0.005" in slightly over 18".

Where tapped holes must be supplied, Rosan inserts are used. All other holes are clearance holes for cadmium plated bolts.

Inspection

The castings, as received, are checked for cracks and surface imperfections by fluorescent penetrant methods, in this case with Zyglo materials and methods, and for hardness. After all of the machining has been done, a second Zyglo inspection is given the parts plus a visual inspection.

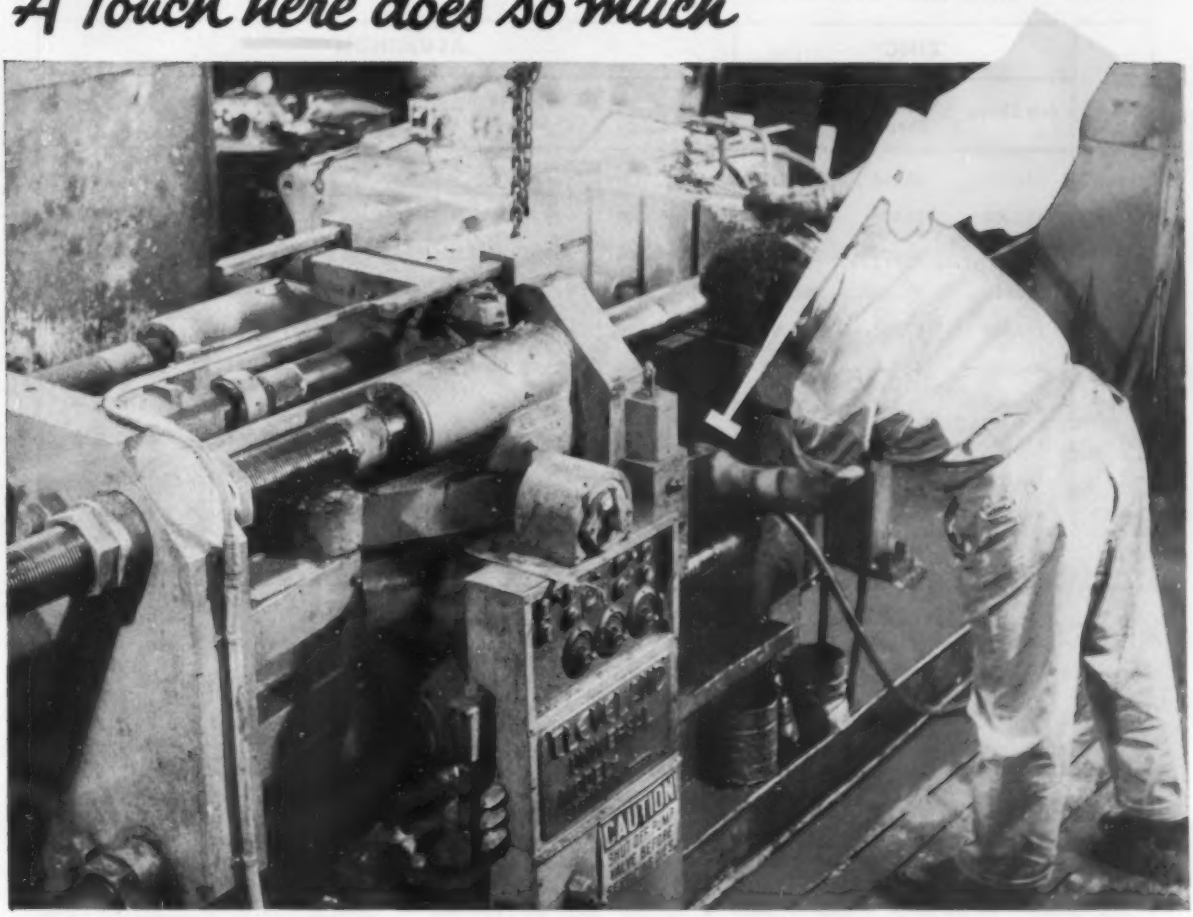
Surface Finishing

The overall surface finish given the casting after machining is a zinc chromate conversion coating, followed by two coats of black enamel on all non-mating surfaces. This conversion coating meets specifications Mil-M-3171 type 3 or AMS 2475. On mating surfaces such as where the second flange fastens on, only a zinc chromate primer is used. The particular dichromate treatment used is reported to have the best combination of properties for both paint base and for protection against corrosion.

This particular part was originally, and in some cases still is, made as a sand casting. When so made, there is considerably more machining to be done. Walls and sections are generally thicker and rejected parts due to casting

Continued on page 55

A Touch here does so much



HEAT AND PRESSURE...

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For more information circle No. 103 on the Reader Service Card

TABLE 1. ZINC AND ALUMINUM DIE CASTING REQUIREMENTS 1946-1956

Year	ZINC*			ALUMINUM**				
	Job Shops	Captive Shops	Total	Job Shops	Captive Shops	Total	For Zinc Alloy	Total
1946	144,000	48,000	192,000	Not Available			Not Available	
1947	158,000	52,500	210,500	91,400,000	18,100,000	109,500,000	16,850,000	126,350,000
1948	148,500	70,000	218,500	100,250,000	18,750,000	119,000,000	17,600,000	136,600,000
1949	116,000	72,000	188,000	76,000,000	12,000,000	88,000,000	15,000,000	103,000,000
1950	170,000	97,000	267,000	127,500,000	16,500,000	144,000,000	21,350,000	163,350,000
1951	146,000	80,000	226,000	106,000,000	22,000,000	128,000,000	18,000,000	146,000,000
1952	133,000	70,000	203,000	127,500,000	28,000,000	155,500,000	16,250,000	171,750,000
1953	172,000	84,000	256,000	185,000,000	51,000,000	236,000,000	20,500,000	256,750,000
1954	146,000	75,000	221,000	168,000,000	55,000,000	223,000,000	17,800,000	240,800,000
1955	275,000	135,000	410,000	270,000,000	82,500,000	352,500,000	32,800,000	385,300,000
1956	234,000	128,500	362,500	262,250,000	105,000,000	367,250,000	29,000,000	396,250,000

* Special High Grade (Tons) **Primary and Secondary (Pounds)

Non-automotive uses for die castings gained last year, although total production was off from 1955 record output, according to this report on . . .

Die Casting Production In 1956

By DAVID LAINE, Secretary
American Die Casting Institute

THE second highest year recorded for die castings was 1956. Production and sales were exceeded, on an overall basis, only in 1955. 1956 was a year marked by mixed patterns . . .

- The impact of the reduction in sales to the automotive industry was offset, to a great degree, by increases in sales to other industries.
- The indicated decline in production of zinc base die castings was countered by increased production in the light metals with aluminum die casting reaching a new high point.
- The changed ratio of job shop to captive production reflects: in zinc, a reduction in automotive industry purchases of die castings that was greater than the decline in car production; in aluminum, in addition, die casting volume produced in a "hot metal" facility.

For 1957, and the future, these 1956 patterns indicate continued growth of die casting production in all metals and a more diversified and stable job-shop die casting industry.

Metal Requirements

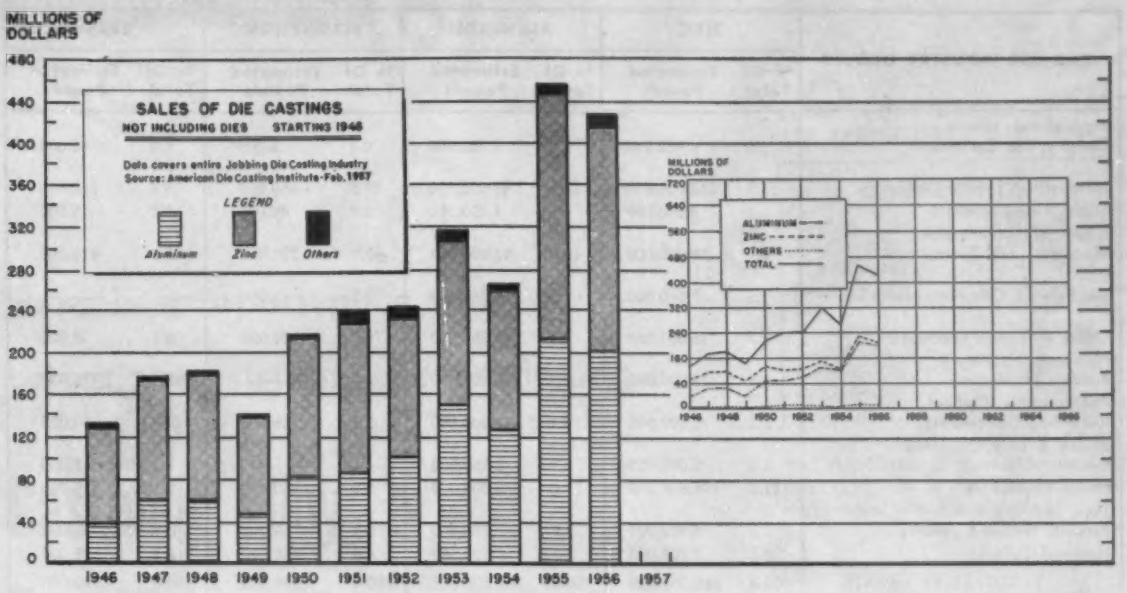
Aluminum consumption for die casting set a new high record in 1956. 367,250,000 pounds of aluminum alloy die castings were produced. In addition, over 29 million pounds of aluminum were consumed in the making of zinc alloys for die casting. This total of 396,250,000 exceeds 1955 requirements by 11 million pounds.

The 1956 die casting consumption of 396 million pounds represents 9.6 percent of the total aluminum supply. Of this die casting requirement, the smelting industry supplied more than 75 percent—the bulk of it in the form of casting ingot. Die casting ingot accounted for approximately 68 percent of total estimated casting ingot sold by smelters.

Of the estimated consumption of primary aluminum for die casting purposes more than 25 percent is believed to have been supplied under 'hot metal' contract arrangements.

Zinc consumption for die casting totalled 362,500 tons in 1956. This represents 36.5 percent of total slab zinc consumption. This total was 11.5 percent below the 1955 record use. Special high grade once again exceeded any other grade of slab zinc used.

TABLE 2. TOTAL DIE CASTING SALES 1946-1956



Magnesium die casting production in 1956 totalled 6,200,000 pounds and marks a high point since World War II when high military demand ended.

Copper consumption for die casting also reached new high ground. Brass die casting amounted to almost 9,500,000 pounds indicating a copper consumption of about 7 million pounds.

Die Casting Production

In 1956, job-shop, or custom, producers of die castings shipped 71 percent of the aluminum, and 65 percent of the zinc, total production. Job shop also accounted for 90 percent of the magnesium, and 66 percent of the brass die castings produced. Captive production by end product manufacturers accounts for the remainder.

In assessing the buy-or-make aspects of die casting production, it must be recognized that the bulk of captive output represents automotive die casting applications. These producers remain very large buyers of die castings as well.

In 1956, reduced automobile unit production had a markedly greater effect on job-shop zinc die casting production than on captive manufacture. Integrated facilities supplied a larger portion of total requirements, a not too remarkable occurrence.

It stresses the need for diversification of sales, and reduced dependence on automotive volume, by the job shops. In 1956 this growing diversification proved a sound counterbalance to the effects of severely reduced automobile manufacture. Further diversification is indicated in the absence of more stable purchasing commitments by automobile producers with captive facilities for die casting production.

In aluminum an additional factor was the increased captive die casting output in the one 'hot metal' plant operating. However, the continuing expansion of die casting use by other industries almost completely offset the drop in shipments for automotive use.

As more industries use more die castings in their products, and as the golden bubbles of do-it-yourself and 'hot-metal' savings burst in the cold light of realistic cost accounting, the historic relationships of job-shop to captive production will continue with minor change.

End Uses of Die Castings

Job shop shipments to major customer industry groups are covered in Table 3. While the total shipments indicated are 82 million pounds of zinc, and 7½ million pounds of aluminum, below the 1955 shipments, it is of interest to point out that shipments reported in Class B, Automotive, dropped 79 million pounds in zinc, and 24 million in aluminum, in 1956 as against 1955.

Automotive use of die castings represented 53.2 percent of zinc, and 35.6 percent of aluminum, job shop die casting output. These figures, while indicating a lower automotive share of total production than in 1955, do not represent a reduction in the use of die casting per automobile. The average weight of die castings used per automobile is estimated as follows:

	AVE. POUNDS PER CAR	
Year	Zinc	Aluminum
1955	68.7	20.3
1956	71.3	29.1
1957	77.0	32.75

Continuing increases in die casting content per automobile are to be expected with aluminum average weights increasing at a stepped-up rate.

The improved diversification of die casting use is more readily apparent in Table 4. This records the highest total of pounds ship-

TABLE 3. END USE DISTRIBUTION OF DIE CASTING SALES IN 1956

END USE INDUSTRY GROUPS	ZINC		ALUMINUM		MAGNESIUM		BRASS	
	% Of Total	Estimated Pounds	% Of Total	Estimated Pounds	% Of Total	Estimated Pounds	% Of Total	Estimated Pounds
Agricultural, Mining, Construction Equipment	1.0	4,900,000	2.9	7,750,000	0.1	6,000	1.0	45,000
Automotive (Motor Vehicles)	53.2	248,000,000	35.6	93,000,000	29.5	1,650,000	5.8	260,000
Other Transportation	1.1	5,200,000	1.5	4,000,000	0.7	40,000	0.1	5,000
Industrial, Commercial Machinery and Tools	8.1	38,000,000	16.0	42,000,000	40.9	2,290,000	18.3	825,000
Electronic & Communications Equipt.	1.6	7,500,000	1.0	2,750,000	0.2	15,000	——	——
Office & Business Machines	3.2	15,000,000	7.3	19,250,000	8.9	500,000	0.6	30,000
Plumbing, Heating & Builders Hardware	4.9	23,000,000	2.3	6,000,000	——	——	55.1	2,475,000
Photographic, Optical, Recording Devices, etc.	2.2	10,300,000	6.1	16,000,000	2.3	125,000	0.6	30,000
Timing & Time Operated Devices; Clocks	1.0	5,000,000	1.3	3,500,000	——	——	1.1	55,000
Home Appliances	22.2	104,000,000	21.0	55,000,000	9.0	500,000	0.3	15,000
Toys, Sporting Goods Personal Goods & Jewelry	1.0	4,900,000	2.9	7,750,000	0.1	9,000	0.8	35,000
National Defense	0.5	2,200,000	2.1	5,500,000	8.3	465,000	16.3	725,000
TOTALS BY METALS	100.0	468,000,000	100.0	262,500,000	100.0	5,600,000	100.0	4,500,000

NOTE: Totals represent all job shop sales. Captive use not included. Source: Reports of Members to American Die Casting Institute

TABLE 4. HIGHEST TOTAL SHIPMENTS OF DIE CASTINGS TO CUSTOMER INDUSTRY GROUPS

CUSTOMER GROUPS	ZINC		ALUMINUM		MAGNESIUM		BRASS	
	1949-1956 Pounds	Year	1950-1956 Pounds	Year	1953-1956 Pounds	Year	1956 Pounds	Year
Agricultural, Mining, Construction Equipment	6,000,000	1955	7,750,000	1956	6,500	1955	45,000	1956
Automotive (Motor Vehicles)	327,000,000	1955	117,000,000	1955	1,950,000	1955	260,000	1956
Other Transportation	9,925,000	1951	4,000,000	1955-6	40,000	1956	5,000	1956
Industrial, Commercial Machinery and Tools	38,000,000	1956	42,000,000	1956	2,290,000	1956	825,000	1956
Electronic & Communications Equipt.	13,400,000	1953	3,900,000	1953	15,000	1956	——	——
Office & Business Machines	15,000,000	1956	19,250,000	1956	500,000	1956	30,000	1956
Plumbing, Heating & Builders Hardware	26,000,000	1950	7,300,000	1955	23,500	1955	2,475,000	1956
Photographic, Optical, Recording Devices, etc.	11,000,000	1955	16,000,000	1956	125,000	1956	30,000	1956
Timing & Time Operated Devices; Clocks	5,500,000	1955	3,500,000	1956	5,000	1955	55,000	1956
Home Appliances	104,000,000	1956	55,000,000	1956	778,000	1953	15,000	1956
Toys, Sporting Goods Personal Goods & Jewelry	9,750,000	1950	7,750,000	1956	23,000	1955	35,000	1956
National Defense	25,100,000	1951	35,000,000	1953	559,000	1953	725,000	1956
HIGHEST ANNUAL TOTAL	550,000,000	1955	270,000,000	1955	5,600,000	1956	4,500,000	1956

NOTE: Job Shop shipments only.

ped by job-shop die casting producers to customer industry groups, and the year in which this high point was reached, for each metal. Zinc and aluminum data cover the years since 1949. Magnesium since 1953. Brass data is for 1956 only.

Dollar sales information has been published by the American Die Casting Institute since 1936. The value of 1956 sales of die castings produced in job-shops was $429,700,000. This sales total covers the value of die castings only. The value of plating or other finishing sold by the die caster is not included. The value of die casting dies and special tooling is also excluded. The additional value of such sales and services exceeds $250,000,000.

The value of captive produced die castings is not available since such die castings are not 'sold' in the usual sense but are included in end-product prices.

The $429,700,000 sales total in 1956 consists of $214,000,000 of zinc die castings, $201,500,000 of aluminum die castings, $7,700,000 of magnesium die castings and $6,500,000 of brass die castings.

Here is a report on a new corrosion resistant, age hardening . . .

Castable Alloy For Highly Stressed Parts

A NEW alloy developed by the Armco Steel Corp. may prove to be of major importance to both the product designer and to the foundryman, particularly in the investment casting and shell mold casting fields.

The alloy, designated as Armco 17-4 PH, is an age hardenable corrosion resistant steel having a carefully balanced formula that gives exceptionally wide design latitude due to its good casting properties, ease of machining when fully annealed, and good strength characteristics when age hardened. Corrosion resistance in the fully age hardened condition is about the same as 18-8 and superior to other hardenable "stainless" alloys. When slightly overaged the material exhibits excellent resistance to stress-corrosion cracking.

Because the alloy is metallurgically a marginal martensitic type, both product designer and heat-treater must be cognizant of, and allow for, the expansion which occurs during the transformation from austenite to martensite. To the designer this means that varying cross-sections, sharp undercuts and sharp internal angles should be avoided whenever possible. When design will not permit the elimination of these possible trouble spots, the heat-treater must control the rate of cooling to prevent cracking or setting up stress concentrations. The designer must also remember that on aging there will be a small contraction. This dimensional change on aging is about 0.00047 in./in.

Some of the properties of this alloy are:

Mechanical Properties

The ultimate tensile strength, yield strength and hardness of fully aged Armco 17-4 PH decrease relatively slowly with increasing temperatures up to about 800°F. Above this temperature the drop is quite rapid. Typical rates of change of the physical properties of the alloy between room temperatures and 1200°F are shown in figure 1.

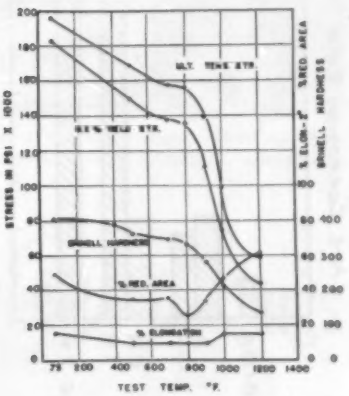
Corrosion Resistance

The corrosion resistance in most media of this alloy compares favorably with 18-8 and is consider-

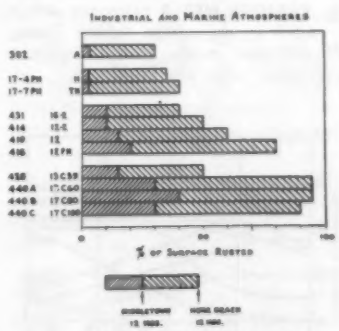
DATA ON COMPOSITION AND PROPERTIES

COMPOSITION	
Carbon	0.07 max.
Manganese	1.00 max.
Phosphorous	0.04 max.
Sulfur	0.03 max.
Silicon	1.00 max.
Chromium	15.50 to 17.50
Nickel	3.00 to 5.00
Copper	3.00 to 5.00
Columbium + Tantalum	0.20 to 0.45

THE FUNCTION of each alloying element and the reason for impurity maximums will be discussed.



1. TYPICAL CHANGE RATES of the alloy's physical properties. These figures show changes occurring between room temperature and 1200°F.



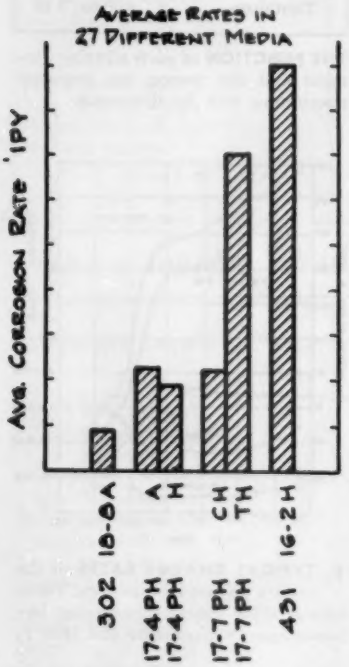
2. CORROSION RESISTANCE facts for industrial and marine atmospheres. Figures seen above represent results of year-long testing program.

TURN THE PAGE FOR MORE DATA

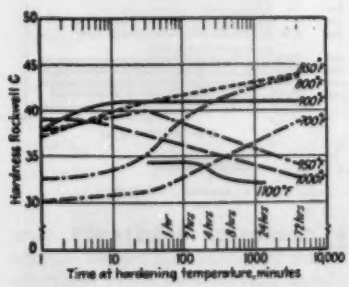
TABLE 1. Mechanical Properties of 17-4PH

	Annealed 1800°F - 1900°F ½ hr.	Hardened 900°F 1 hr.
Ultimate tensile strength, psi	135-165,000	190-210,000
Yield Strength, .2%, psi	95-125,000	170-200,000
Proportional limit, psi		115-140,000
Elongation, % in 2 in.	6-15	6-15
Hardness R_c	30-35	40-45
Izod Impact, ft. lbs.		10-20
Modulus of Elasticity, psi		28,500,000

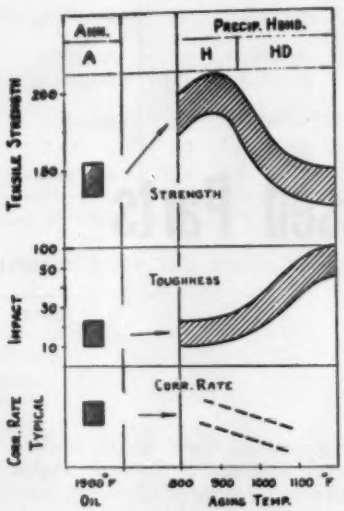
MACHINABILITY of this alloy is good. The important mechanical properties of the 17-4PH alloy are tabulated above.



3. VARIOUS MEDIA rates are averaged in the above tables. Using 27 different media, these medium corrosion rates are tabulated.



4. WIDE RANGE of properties is obtained by varying aging times, and temperatures as shown in the chart. Hardness is indicated at left.



5. TOUGHNESS AND STRENGTH are affected as seen here by altering either time or temperature factors.

CASTABLE ALLOY—continued

ably superior to other hardenable grades of stainless steel. The comparative corrosion resistance is shown in figures 2 and 3. The combination of high strength and hardness with excellent corrosion resistance can be a controlling factor in the use of this material.

As noted above, when Armco 17-4 PH is over-aged; i.e. aged at from 1000°F to 1150°F; it shows outstanding resistance to stress corrosion cracking when compared with other materials at similar hardness levels (1).

(1) Stress Corrosion Cracking of Hardenable Stainless Steels, by F. K. Bloom, Corrosion, Vol. 11, No. 8, pgs. 351-361, August, 1955.

Hardening

The austenizing temperature for this steel is about 1900°F. At this temperature all of the carbon and the copper are in solid solution. Quenching from this temperature retains the copper in a super saturated solution and permits the transformation to martensite to take place. The start of the transformation is about 250°F and is virtually complete at 90°F. To insure complete transformation, the metal should be cooled to 70°F. In this condition the alloy consists of a "soft martensite."

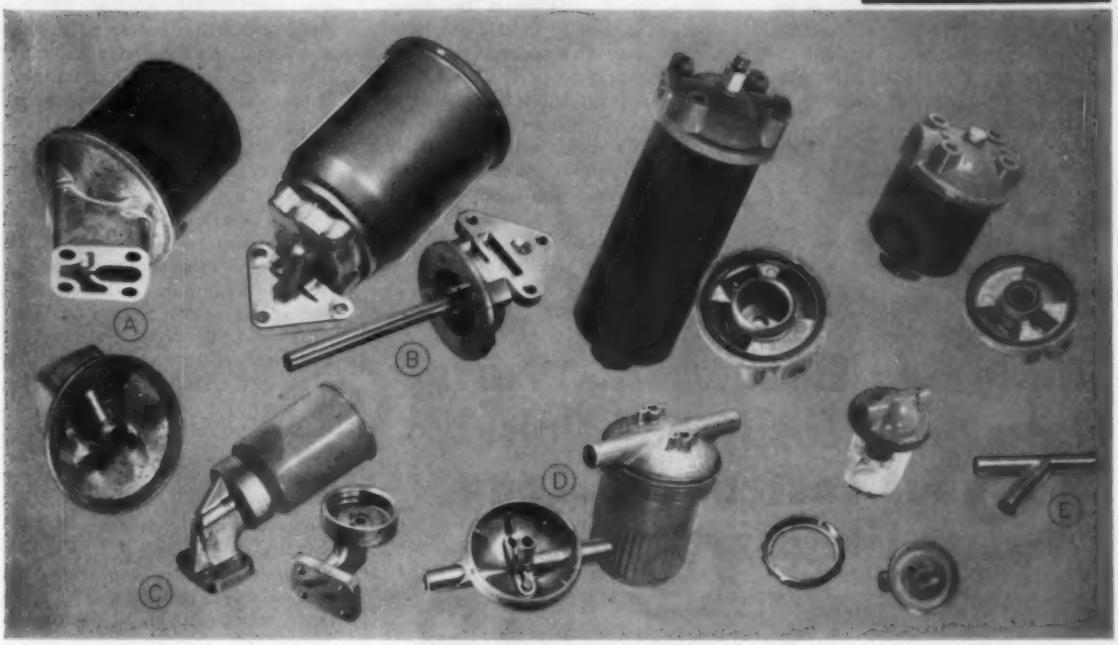
As noted, the transformation is accompanied by a volumetric expansion. To avoid thermal cracking the rate of quenching must be controlled. On section thicknesses up to 3", an oil quench can be used; from 3" to 6" sections require air cooling and on sections above 6" a light metal cover should be used to insure slower cooling through the transformation range. This treatment insures a fully annealed part that can, if necessary, be machined quite readily. See Table I.

Basis for this report on the various properties and characteristics of 17-4PH alloy is a paper delivered before the Investment Casting Institute in November, 1956, by W. C. Clarke of Armco Steel Corp.

Elevated temperature aging is to precipitate the copper rich phase within the matrix to cause hardening. For maximum strength the alloy should be aged for 1 hour at 900°F. By varying the aging time and/or temperature a wide range of properties can be secured. This dependence of properties on both time and temperature is shown in figures 4 and 5. It is evident from the data presented in the curves that a very wide range of properties is possible and in some cases it has been most desirable to deliberately over-age to improve the ductility and toughness properties, though this entails some sacrifice in both hardness and strength.

Aging temperature also changes the corrosion resistant properties of the alloy. The dependence of corrosion resistance on tempera-

Continued on page 106



1. **OIL TIGHT** and strong enough to withstand engine vibration, these filter castings help to produce low cost automobile accessories.

To meet severe competition

Auto Parts Maker Uses Precise Castings

By R. A. PLANTE, Chief Designer
The Fram Corporation

THE automobile replacement parts field probably represents one of the most competitive markets in existence. Designing in this field, therefore, requires the utmost ingenuity to produce quality products that can be sold within, or below, existing retail price brackets. This is particularly true when the part to be made is a disposable one; some oil, water and fuel filters fall within this class.

Because these filters are in this highly competitive market, it is essential that every possible manufacturing short-cut be taken. All operations that involve much hand labor, whether skilled or unskilled, must be reduced to a minimum; wherever possible both die castings and permanent mold castings are utilized.

The ability of these processes and the know-how of the foundry men permit highly complex coring, thin and thick sections in juxtaposition, inclusion of metal savers in places where sand casting, for example, could never hope to compete and an almost complete elimination of machining except for such simple operations as drilling, tapping and surfacing.

The filters and castings illustrated in Figure 1, clearly show how these two methods of casting have been able to produce parts that, by any other method of manufacture, would require relatively great expenditures of skilled labor, the design and construction of complex and expensive jigs and fixtures, and a very considerable waste of metal in the form of machining scrap. Further, if considerable amounts of machining were done, it is inevitable that sub-surface defects so prevalent in sand castings, would be disclosed with a consequent high rejection rate. Some of these castings illustrated are well worth closer inspection.

The base casting for the filter shown in Figure 1a is an aluminum permanent mold casting. Originally, this part was designed as a sand casting and, as production increased, was converted. Because this precision casting method is inherent of high accuracy, the only machining that is required is to face the casting where it mounts on the engine pad and to tap a few holes. The steel tube which serves to hold the cover on the filter body is locked into a cored hole which connects with the angular cored hole acting as an oil outlet. In this case, the cost of the finished casting, ready for assembly, is 36 percent less than the corresponding sand cast

part at the same degree of completion. A further advantage of the permanent mold castings is in the lower number of rejects. While the precise percentage of castings that are rejected due to foundry faults is not known, it is known, that such rejects are well under 2 percent and that this rejection rate is considerably below the corresponding figure for sand castings.

The die casting shown in Figure 1b again represents the tremendous savings that are possible with die casting. The only machine work that must be done on this casting is to tap one hole and to face the surface that fits onto the engine pad. Where the two cored oil inlet holes intersect, it is sometimes necessary to clean out a small amount of flash and this is done by the foundry in the course of routine trimming. The large metal savers, as well as the cast-in by-pass, are further advantages that are gained through the use of the die casting process. A further advantage from the use of die castings in this case is that the entire part, fully machined and ready for assembly is delivered, thus all machining operations by the purchaser are completely eliminated. In some cases, this can mean the difference between purchasing new machine tools or not.

Both internal and external threads can be cast by both the permanent mold casting and die casting. Examples of threads that are so cast are shown in Figures 1c and 1d. In the case of the internal threads, the casting must, of course, be removed from the core pin by unscrewing it. In spite of the lower production rate that such an operation entails, permanent mold casting for this part is still far less costly than sand casting and subsequent machining.

The water filter cap shown in Figure 1d represents a change from permanent mold casting to die casting. This change was dictated by increased production which made die casting the more economical method. No comparative costs are available for this method change since the entire cap was completely redesigned by the casting vendor at the time of the change. This sort of redesign emphasizes the need for close co-operation between the vendor and the purchaser. Because this co-operation existed, a better functioning part, at a considerably lowered cost, was achieved than if a direct conversion using a static design were the case.

Another example of the intricate coring that can be done by die casting is the "Y" shown in Figure 1e. This part is readily cast with a thin uniform wall. Fabrication by other means would mean machining two tubing sections and then brazing or welding them together. Costs would be high and the danger of leakage at the joint very considerable. On the cast part, other than normal trimming, it is only necessary to remove light flash at the intersection of the two cores. This operation can be done extremely easily and rapidly.

Surface finishing for all of the die castings is quite simple. When necessary, a conversion coating, such as a phosphate or chromate treatment is given and then some of the parts painted and baked.

Machining Eliminated...Parts Assembled Easily And Quickly Without Fasteners...Long Service Life Assured With...

ACCURATE Die Castings

■ Typical of the many cost saving die castings produced by ACCURATE are these electroplated corrosion-resistant zinc die castings which were used to manufacture a more efficient and eye appealing reel-type jalousie operator. Since the castings have a smooth non-porous surface and are held to close tolerances, they were used as-cast, thus eliminating costly secondary operations. In addition, the dimensional accuracy of the five spur gears and mounting posts permitted fast trouble-free assembly and lowered unit cost. Finally, to lock the component parts into a permanent dust-proof assembly five spinning or penning operations of the die cast metal were performed to eliminate the use of all fasteners.

If you are concerned with how to improve your products and lower costs, it will pay you to take advantage of our experience.

Major producer of Aluminum, Zinc and Magnesium Die Castings.

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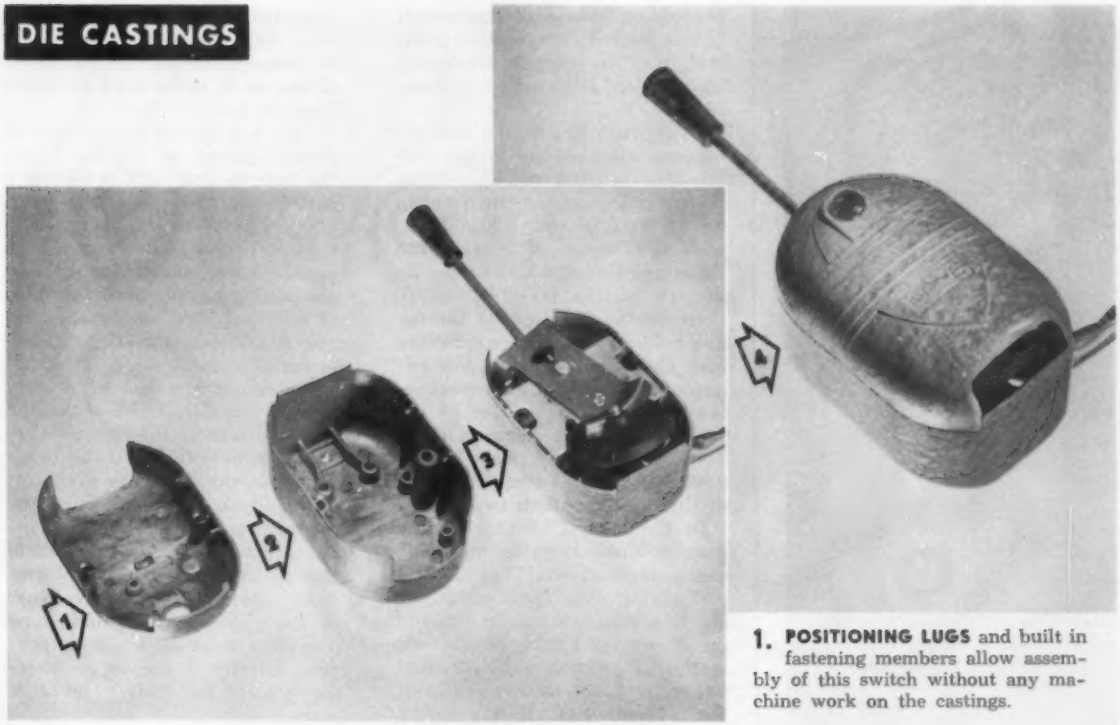

1. **POSITIONING LUGS** and built in fastening members allow assembly of this switch without any machine work on the castings.

Built In Fastening Members . . .

aid high speed assembly

A SINGLE pole, double throw switch for the manual operation of automotive turn signals allows the use of a simple housing that must only have sufficient rigidity to withstand normal abuse and vibration. Accuracy and alignment of mounting holes and bosses are relatively unimportant so long as the switch can be mounted in a convenient operating position. Stampings are usually satisfactory for this non-critical use.

But, when the turn indicator switch is to be self-cancelling, the requirements for accuracy, alignment and rigidity are greatly increased. It now becomes economically unsound to house it in metal stampings; the manufacturer quite naturally turns to die castings as the method of manufacture.

By die casting, all mounting members can be included in the housing without any machining, assembly or joining operations. Rigidity is assured by either casting a heavy wall section or by including stiffening ribs. As an example, consider the self-cancelling switch made by K-D Lamp Co.

Figure 1 illustrates the clean, smooth streamlined appearance that is achieved through the use of die cast housing members. These castings have been assembled without having to do any surface finishing other than painting. The fabricator has done a sufficiently good job of casting and trimming so that the castings, as delivered, are ready for painting.

The maximum surface preparation that is ever needed is a degreasing operation and, in many cases, even this is not required. The final surface finish given these castings is to use a so-called Hammerloid paint. This material is applied by spray and is baked at 275 F for 18 minutes.

A look inside the castings, Figure 1, reveals the big reason for using die castings . . . all mounting members, whether bosses, screw holes or simply supports and guides for sliding parts, are formed as a part of the casting. Locking devices to assure proper alignment of the cover and main housing are cast-on. Only machine operations performed on the castings are the tapping of six holes in the body casting and two holes in the cover.

Figure 1 also shows an assembled switch with the cover removed. The sliding plate indicated is responsible for the proper functioning of the self-

Which alloy should you specify for your castings?

Valuable reference data on alloys and their properties, plus pertinent design facts to help you in designing and buying investment castings, will be featured in PMM's June issue. It will also have a complete buyers' guide with sources for investment castings, and the alloys and equipment for producing them.

The 2nd Annual

INVESTMENT CASTING DIRECTORY

If you sell investment castings or the alloys or equipment for making them, your ad in the June issue of PRECISION METAL MOLDING will be read and saved for a whole year.

cancelling feature of the switch. If this plate does not move freely and stay in proper alignment, the friction drive will not function.

Experience has shown that the maximum lateral movement permissable is 0.005 and the maximum vertical movement that can be allowed is also 0.005. These tolerances mean, of course, that *the supporting and holding guides on the casting must be within these limits. The as-cast bearing and holding portions are indicated and these are held to the required dimensional tolerances by the foundry.* In the case of the width between the aligning members, the required accuracy of 0.005 maximum is over a distance of slightly more than two inches.

In the bottom of the housing casting another guide and stop assembly is shown. This is for a leaf spring that applies the required pressure to hold the switch in left or right turn position or in the off position until actuated either by hand or by action of the friction drive. If this spring is out of alignment or is not properly positioned lengthwise, it will apply unequal pressure and cause malfunctioning. Therefore, the width between the aligning members and the position of the end stop with reference to the cored hole is important. Tolerances on the location of the spring guides need not be as close as on other members and is held to a total variation of about 0.030.

Another feature of the housing is the inclusion of the beveled edge on the end over and under the friction wheel. Without any added cost, this bevel is included in the casting and helps to make the finished switch better appearing. Were it not possible to cast this bevel on the housing, either greater opening width would have to be allowed at the sacrifice of appearance or the bevel machined on as a separate, expensive machining operation. The cover casting has, of course, a matching bevel also secured in the casting operation.

Another advantage secured from die casting: the small jewel mounted in the cover above a light is a standard plastic unit designed specifically for this type of use. Its design, however, is for inclusion in sheet metal panels, not for the far heavier wall thickness used in the switch cover.

These jewels are made to be mounted on flat surfaces and that requires a projecting boss to compensate for the curvature of the cover at the most desirable location for the light.

This positioning of the boss is clearly shown in Figure 1. On the reverse side of the casting a cast-in counter bore has been formed leaving a metal wall thickness that is correct for a standard size plastic jewel. Here die casting has obviated the need of a special jewel or a machining operation, thus lowering manufacturing costs again.

To mount the switch a steel bracket is clamped around the steering column; the switch housing is then fastened to the bracket. Provision must be made for some adjustment to secure the proper pressure between the rubber drive wheel and the hub of the steering wheel. Adjustment must also provide for wear of the rubber wheel and some provision must be made to prevent turning of the entire housing when the switch lever is moved.

Figure 2, shows the underside of the main housing casting. Two lengthwise ribs, both of which are an integral portion of the casting, are evident.

2. FOR POSITIONING and rigidity, integral ribs are cast-on.

The mounting bracket fits snuggly between these two ribs and is fastened to the housing with two machine screws. Short slots in the bracket member allows movement of the housing along the bracket, to secure the proper pressure between the rubber drive wheel and the steering wheel housing. The ribs prevent any twisting of the housing so that alignment is never lost.

The design of these ribs is such that they will withstand far higher shear stresses than it is possible to apply without damaging the switch mechanism itself.

PMM

Finishing Section

The specialized finishing methods, equipment and materials used to machine, assemble, surface condition or surface coat precision metal molded parts are presented here. This includes all secondary operations which convert a raw casting to a finished product.

"Ball-burnishing of racked die castings has sharply reduced finishing costs." See page 52

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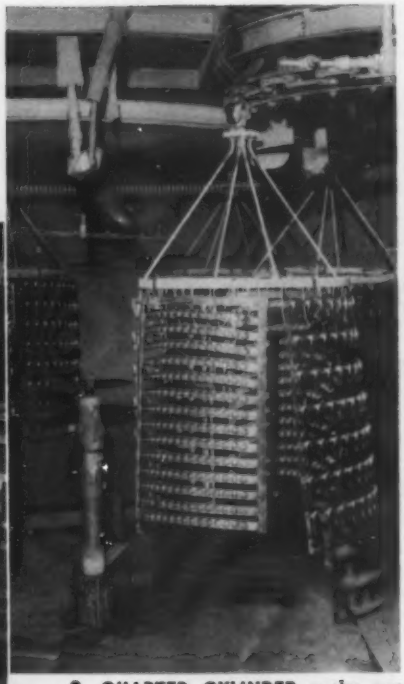
1. MERRY-GO-ROUND fixture rotates the racked die castings around the electrostatic spray head, giving uniform coverage. Thi sarrangement permits the finishing of a large number of pieces simultaneously.



2. QUARTER CYLINDER racks are used, four at a time, in the electrostatic paint spraying.

A fully automated finishing department combines . . .

Electrostatic Paint Spraying And Plating

By WILLARD G. AXTELL
Swayder Bros., Inc.

IN the manufacture of luggage, certain of the components, notably latch and lock components, must be metal regardless of any other materials of construction that may be used in the case being built. Since many thousand different pieces of hand luggage are made per day, it follows naturally that as many of the metal components as possible are die cast in zinc.

Because the surface coverings vary widely in both color and texture, it is imperative that different methods of surface finishing of the die castings be employed. Experience over a number of years has shown that practically all functional and decorative finishes that are needed can be secured by either electroplating or by spray painting.

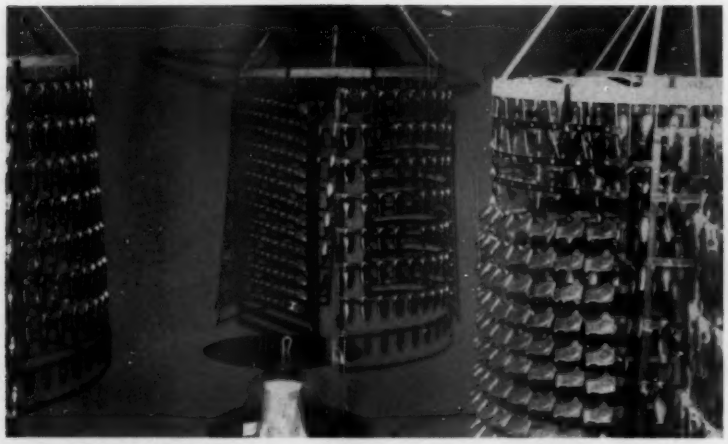
Regardless of the final finish that is to be given the die casting, the initial preparatory steps are similar. The parts go from the die casting machine where they are cast in multiple cavity molds to the trimming line. Here power operated and kick presses are used for removing gates, runners, flash and other extraneous metal. In a few isolated cases some minor machine work such as drilling may be done.

Following trimming, and any needed machining, all of the die cast parts are thoroughly cleaned and degreased. The cleaned parts are now ready to go their separate ways to either the painting or the plating departments.

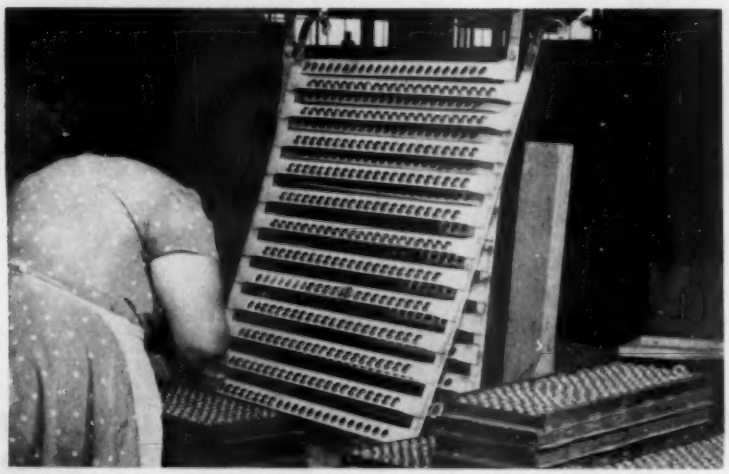
Painting and Enameling

For the service intended for these die cast parts, no surface treatment or prime coating is required. The individual trim parts are placed on curved racks (four racks when hung from the conveyor form a complete cylinder) as shown in Figure 2. These racks are then hung on a conveyor line which will carry them through the spray booth and the drying.

As the sets of four racks are advanced they pass in front of a



3. PROPER BALANCING of speed of rotation and rate of traverse makes it possible to control the voltage drop across the air gap between electrostatic unit and the die cast parts.



4. HAND TOUCH-UP picks up any surfaces that may have been missed in the automatic paint operation.

5. WITH 264 PIECES PER RACK, the zinc die cast pieces are given a brass electroplate in a still tank.

Ransburg No. 2 Electrostatic spray unit, Figures 3 and 4. Here the cylinders formed by the racks are slowly rotated while paint is sprayed onto the die cast parts. Because of the high electrostatic potential between the atomizing disc and the parts, which are grounded, the paint droplets are attracted to the slowly moving parts. By properly balancing the speed of rotation and traverse of the parts, the voltage drop across the air gap, the rate of paint feed, and the atomizing disc speed the amount of paint deposited can be carefully controlled.

Where-as with hand spraying curved surfaces might not be as completely coated as desired, with electrostatic spraying all exposed surfaces are uniformly covered. Where necessary the paint droplets can be made to curve around so as to coat under surfaces. Further, since all of the paint leaving the atomizing disc is charged, it will all go to some point where discharge can take place. Also, since the field strength varies as the fourth power of the distance, the paint particles will naturally take the shortest path to ground—in this case the parts to be coated. This desire for discharge and the proximity of the grounded parts results in almost complete absence of over-spray. With hand spraying, it is essential that there be an operator for each spray gun, but with the improved system the entire finishing process except for loading and unloading becomes automatic.

Following the spraying, the parts pass into a drying oven where they are baked at 325°F for 20 minutes. An air-drying leg is, of course, installed between the spray booth and the drying oven so that the majority of the solvent and the volatile portion of the vehicle can be evaporated before final drying and baking. Also, a cooling leg must be provided between the oven discharge and the unloading station.

Plating

Certain of the die cast parts must, because of service requirements, be plated. Brass plating is used almost exclusively and the procedure followed is standard in every respect. Parts are racked as shown in Figure 5, in this case 264 pieces per rack. Still tank plating is used.

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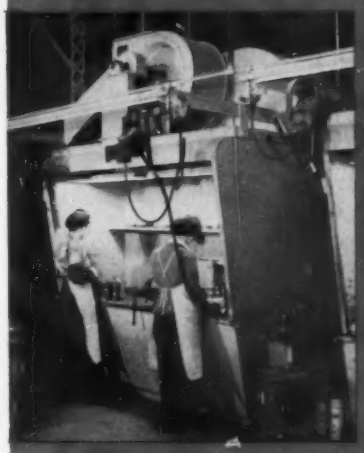

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Illustrated here are four types of PD Wet Type installations. *Upper left*—well ventilated bench for the safe collection of dust produced from portable tool and flexible shaft grinding, polishing and buffing; *upper right* — dust collector for grinding stands and polishing jacks; *lower left* — water-wash type spray booth for removing noxious fumes created while spraying oxidation inhibitors containing fluorides or other toxic compounds on cores; *lower right* — high velocity side hood wet collector for dust, fumes and smoke during a foundry "shakeout" operation.

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2. **RACKED CASTINGS** fit into the polishing barrel, one loaded rack at each door in the octagonal barrel.

Ball burnishing after surface treatment permits

Tarnish-Resistant Surface On Aluminum

Kitchen-Quip, Inc., Waterloo, Indiana
By F. M. METRAILER, General Manager

CONVENTIONAL ball burnishing of aluminum alloy parts in a soap solution, is an old and low cost process but generally yields a finish greatly inferior to that attained by wheel polishing and buffing. Wheel work is expensive, however, and, on most die castings, produces a surface that soon tarnishes unless plated or otherwise protected.

Most of the die castings used by Kitchen-Quip are in AXS 679 aluminum alloy that contains silicon and copper as primary alloying elements. Until recently, such castings were ground to remove parting lines and then were hand polished and buffed before plating or other finishing. This finishing proved expensive and, on some castings, was not satisfactory, partly because recesses were not accessible in wheel work.

Initial experience with barrel finishing, however, was not satisfactory. Castings tumbled in ball mixtures were subject to impingements that marred surfaces and the degree of brightness produced was not satisfactory. Continued experimental work was done and a Roto-Finish barrel having a synthetic rubber lining was installed after tests made by the barrel promised manufacture promised good luster at low cost.

To avoid impingement of part against part, all parts processed in this barrel are fastened on fixtures so clamped under removable barrel covers that both parts and fixtures rotate with the barrel. Fixtures cannot come loose and parts cannot tumble about. With this setup, good results were attained, steel burnishing balls "flowed" around the parts and, in combination with No. 355 Roto-Finish compound,

3. TWENTY MINUTES in the barrel with steel balls for burnishing is enough to produce a bright surface.

4. PART SHAPE is no barrier to the production of a bright finish suitable for direct use or plating.

produced excellent burnishing but, on aluminum alloy, tarnishing soon occurred.

It was known, however, that a high luster could be produced on substantially pure aluminum and that this luster would remain bright for long periods without a protective coating. But, on die casting alloys, the luster produced finger printed and did not remain bright; this was attributed to alloying ingredients on the surface.

Continuing experiments showed that, if the alloying elements on the surface were removed by acid etching, and ball burnishing of racked parts in the barrel was then done, a brilliant finish was attained. This finish was stain free, afforded prolonged resistance to tarnishing and held its color well. The finish did not fingerprint and parts had good shelf life. Accordingly, such processing is now done on aluminum castings on a large scale and with savings of as much as 65 per cent compared with the former wheel polishing and buffing.

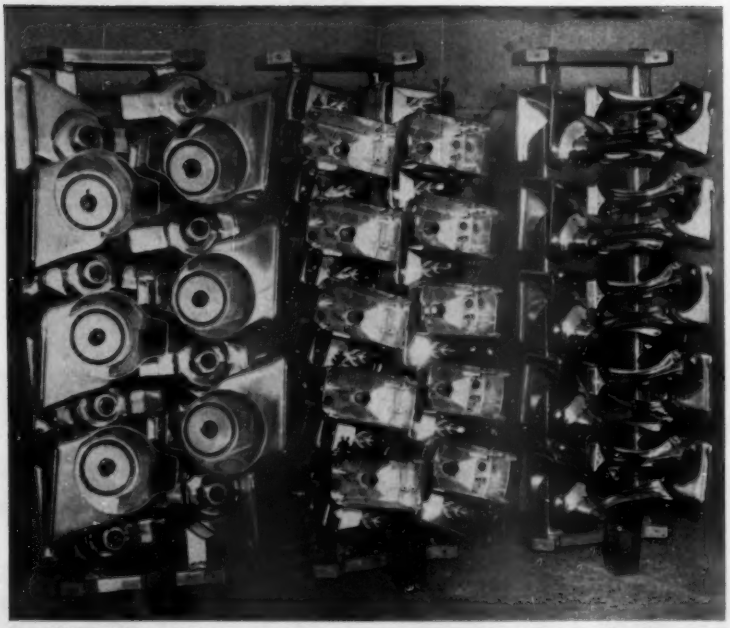
The new processing has not only yielded savings of importance, but the superiority of the finish is so pronounced that sales are increased. Now, several other industrial users of die castings are sending them to Kitchen-Quip for this finishing. They like both the appearance and the freedom from burrs and sharp edges.

Equipment employed is quite simple and includes a chain driven octagonal barrel. This barrel measures 54 in. in diameter, across flats, and has on each face a clamped door covering an opening 30 in. long and 20 in. wide. In the barrel, 2,000 lb. of hard steel balls of ¼ in. and 3/16 in. diameter are used. They form a mass 16 in. deep and are kept covered with water to a depth of 6 in. above the balls. Four pounds of No. 355 compound are placed in the barrel once in each 8-hour shift. This compound helps to keep balls clean and to improve their burnishing action.

After die cast aluminum parts to be burnished have had flash lines removed by abrasive belts, the parts are cleaned in a hot, controlled-etch alkaline cleaner and then are rinsed twice in cold running water. Next, the parts are dipped for 5 to 10 seconds in a concentrated solution of nitric and hydrofluoric acid at room temperature. This carefully controlled solution attacks and etches out alloying elements on the surface of the castings but does not readily attack the aluminum, which is left in essentially pure form.

Acid etching is followed at once by two cold water rinses and care is used to see that castings remain wet until placed in the barrel after racking to prevent staining. Before castings are placed in the barrel, they are fastened to racks, several of which are shown loaded and in the process of loading in Figure 1 and 2.

Racks are made largely from aluminum but some fastening parts are case hardened steel. These latter include the studs that, in most cases, receive nuts for holding the die castings in place. Some small parts, however,



5. DIFFERENT SHAPES and sizes can be processed at the same time with suitably designed racks.

6. CHROMIUM PLATING on aluminum is done in the conventional manner in automatic machines after a zinc dip.

are fastened by steel springs similar to those used on plating racks, as springs help to make loading faster. At each end, each rack has two triangular projections that fit into recesses in the barrel frame to locate the rack properly.

If castings have male threads, wing nuts are screwed over these threads so that burnishing action in the barrel will not round the crests of the threads. Castings are so placed that balls can circulate readily and uniformly over exterior surfaces when the barrel is rotated. There is, however, considerable burnishing of interior surfaces. This not only improves their appearance but is said to have a favorable effect upon assemblers who handle the castings subsequently. They like freedom from burrs and sharp edges and can see interiors better.

Each fixture holds from 6 to 48 castings, depending upon casting size, and, when the barrel is stopped for loading and unloading, eight fixtures are removed in succession and eight others already loaded are put in place quickly.

Every fixture is held in place by the cover which is locked when cover clamps are fastened. Covers are taken off one at a time when at the high position, as in Figure 2, and are replaced after the new fixture is set into place and before jogging the barrel to bring the next cover to the top.

After a full set of eight fixtures is placed in the barrel, rotation is started and continues at 21 rpm for 20 minutes. Each three minutes, the direction of rotation is reversed automatically, so that uniform burnishing will take place. At the end of the 20 minute cycle, the barrel is stopped for changing loads.

Burnishing produces slow wear on balls and occasionally balls break. The balls remain in the barrel continuously, however, except when screened about once in 18 months to remove broken pieces. Ball size is chosen so that balls will reach into fillets and recesses (which are burnished better than in wheel work) but will not lodge in holes in the castings.

As balls slowly discolor while burnishing, they are cleaned once during each 8-hour shift. This cleaning is done after flushing out the barrel and then adding 2 lb. of No. 301 Roto-Finish compound and 40 gal. of clean water. After the cover is put back and locked, the barrel is rotated for one hour of cleaning action. Then the barrel is opened and is flushed out three times before being used for the next batch of castings.

Although castings are cleaned before being put into barrels, small quantities of chips and oil might remain in tapped holes and be discharged into the barrel during burnishing cycles. Beside

cleaning the balls, washing out of barrels helps to remove such fine metal chips and oil as may have accumulated in the barrel.

Fixtures for castings are changed in details of design to accommodate different sizes and shapes of castings but in some cases can be used for more than one different shape. Figure 5 shows three racks filled with three different shapes of castings, all of fairly large size. For smaller castings, more pieces per fixture are accommodated. Figure 4 shows typical castings, some of which are already burnished and some before burnishing. This photo provides a good idea as to the range in size and shape of castings processed advantageously.

As some castings are burnished better in one particular position relative to the fixture and barrel than in other positions, experiments to determine the best position sometimes are made before quantities are processed, but, in general, experience enables an operator to make a good guess as to a favorable position and if he finds that this gives good results in the usual cycle time, further tests are not needed.

In Figure 1, a full set of aluminum die castings used in a two-quart home ice cream freezer are shown after ball burnishing in the manner already described and subsequent chromium plating. Finish has to be of high grade to meet the requirements of the freezer manufacturer and his customers. This finish is nearly equal on all surfaces to one in which wheel polishing and buffing are done prior to plating and is much superior on surfaces hard or impossible to reach with wheels. Abrasive belts are used to remove parting lines on castings before cleaning and burnishing are done.

SCHOLARSHIP ESTABLISHED AT LEHIGH UNIVERSITY

Establishment of a scholarship at Lehigh University, Bethlehem, Pennsylvania, as a memorial to Edward Magnuson, founder of Magnuson Products Corporation, has been announced by Ingrid Magnuson, president of the company.

The scholarship, which will be activated in the spring semester of 1957, will be awarded annually by the University to an undergraduate.

AERIAL REFUELING

continued from page 36

flaws are relatively common. With permanent mold castings, all of the advantages detailed above are realized and there are no rejects due to casting flaws.

The other flange end, not illustrated, is normally an aluminum or magnesium sand casting Here one of the peculiarities of the military prevents the use of a permanent mold casting. For those units built for the army, an aluminum flange end must be used since the fuel passes through channels in the casting and army regulations prevent the use of magnesium in contact with aircraft fuel. The navy, on the other hand, allows the use of magnesium in this service. Since the number of units built does not justify duplication of tooling, all of the flanges that carry fuel from the tanks to the hose are sand cast in either aluminum or magnesium.

While no comparative figures are available, it is probable that there is little difference in final costs between sand cast and permanent mold cast parts. However, the great advantage offered by lighter weight, less machining and zero rejects when a permanent mold casting is used, makes this the more attractive of the two processes.

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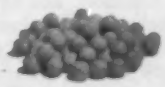

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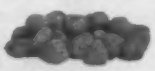

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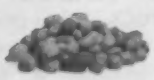

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Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a nonporous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

If your company is manufacturing or buying parts or complete assemblies made from or plated with any of the more common non-ferrous metals—zinc, cadmium, aluminum, magnesium, silver, copper, brass or bronze—you've probably already run up against the question of finishing these surfaces with a chromate conversion coating. These coatings are used to protect against corrosion, or to provide a base for paint or to provide a decorative finish for sales appeal or shelf life. Since chromate conversion coatings represent a relatively new means of obtaining these finishes, this digest of facts to consider may be of value to you.

1. THE COATINGS THEMSELVES. There are many brands on the market. All are similar in many ways. Each, of course, offers its own specific advantages and these may relate to operating techniques, performance under actual use conditions, cost, availability, etc. Naturally, you'll want to choose a coating that is widely known and accepted under both military and civilian specifications.

2. THE COMPANY BEHIND THE PRODUCT. Is it a reliable, established organization? Does it offer experienced technical service, both from the field-engineering organization as well as the home office and laboratories? The man who sells and services your installation should be thoroughly familiar with not only chromate conversion coatings and their applications, but also with the characteristics and performance of related finishing operations such as precleaning, electroplating, painting, etc. This is most important since all steps of the finishing cycle must be functioning properly for the satisfactory performance of the ultimate finish produced.

3. AVAILABILITY OF THE PRODUCT. Ideally, of course, the material should be readily available to you from nearby warehouses to avoid time loss in long distance shipping and to provide emergency service, should the need arise.

4. COST. Naturally, the initial price of the material is important to you. However, just as you consider ultimate cost when you are buying mechanical equipment, ultimate cost must be considered for these finishing chemicals. So, it will pay you to investigate consumption costs, labor costs and the other factors which go into the determination of ultimate cost. Further, cost alone gives no indication of product performance, so careful attention must be given to the purpose the finish must serve and the value that finish will add to your product.

5. FACILITIES FOR RESEARCH AND DEVELOPMENT. Perhaps the existing types of chromate conversion coatings do not include a compound that will accomplish exactly what you wish. Then, it is important to deal with a supplier who has adequate research and development facilities available to work with you to produce a material to meet your needs. Naturally, such a project is seldom completed overnight. But, with complete cooperation and confidence from both you and your supplier, chances are a satisfactory program can be completed.

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For complete information on Iridite chromate conversion coatings, write today for your free copy of our technical data file. Or, for immediate advice, call in your Allied Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

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PMM PEOPLE

changes & appointments

Conrad F. Nagel Jr., vice president of *Aluminum Co. of America*, has retired after more than 41 years with the company. One of the light metal industry's outstanding scientists, he was instrumental in establishing aluminum as a major material for aircraft by determining and eradicating causes of excessive corrosion.

Four executive appointments have been announced by *Crane Packing Co.*: **Carl E. Schmitz**, formerly vice president in charge of sales, now executive vice president; **Vance E. Vorhees**, formerly assistant general sales manager, now vice president in charge of sales; **B. H. Stenberg**, formerly works manager, now vice president in charge of manufacturing; and **E. H. Stubenrauch**, formerly divisional sales manager, now assistant general sales manager.

George W. Stamm has been appointed general manager of sales of *Crucible Steel Co. of America*.

The following appointments in *The Diversey Corp.'s* national sales management have been announced: **R. C. Perry**, general sales manager; **J. M. Sharp**, eastern regional manager; **J. K. Bradford Jr.**, southern regional manager; and **J. R. McBrien**, Pacific regional manager.

E. Lacy and **John C. Ruttle** have been named technical service representatives by *Oakite Products, Inc.* Mr. Lacy will be located in Houston, Tex. and Mr. Ruttle will be stationed in Detroit.

L. Richard Chasen has been appointed advertising manager by *Gries Reproducer Corp.* He will coordinate the company's advertising and other sales promotion activities.

William D. Signer Jr. has been named service engineer at the Rochester offices of *Acheson Colloids Co.* His territory will include western and central New York state and Erie County in Pennsylvania.

J. A. Cairns has been elected to the board of directors of *Allied Research Products, Inc.*

Jackson How has been appointed director of public relations by *American Smelting and Refining Co.*

William R. Swift has been appointed general field service representative for *Cowles Chemical Co.*

The *Neilson Chemical Co.* has announced the appointment of sales and service representatives in three territories: **John W. Decker**, eastern Pennsylvania, eastern New York, New Jersey, Maryland, and Delaware; **Willis J. Stoddard**, Detroit and Michigan; and **James W. Erwin**, western Pennsylvania and southwestern New York.

W. J. Williams has been elected vice president and treasurer of *Aluminum Industries, Inc.*

Dr. B. D. Thomas has been appointed director of the *Battelle Memorial Institute*. He succeeds **Dr. Clyde Williams**, who will continue to serve as the institute's president.

Roy F. Nosek has been named sales manager of the *Beardsley & Piper Div. of Pettibone Mulliken Corp.*

E. B. Thompson, formerly assistant sales manager of *Parker Rust Proof Co.*, has been appointed general sales manager.

H. D. Bryk has been appointed manager of operations of *Alloy Precision Castings Co.*

Delbert A. Burman has been appointed buyer in *Crucible Steel Co. of America's* purchasing department. He will be responsible for purchases of miscellaneous scrap and raw materials.

Lyman A. Bliss has been named president of *Union Carbide Nuclear Co., a division of Union Carbide and Carbon Corp.* He succeeds **Kenneth Rush**, a UCC vice president, who will have overall responsibility for the company's nuclear and international activities.

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of KALAMAZOO
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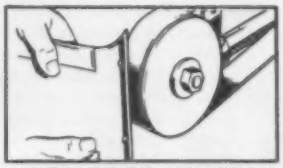
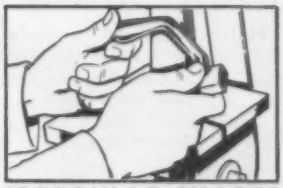
DEBURRING
ECONOMY

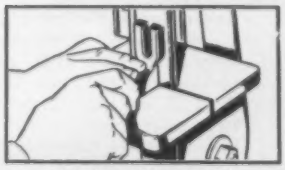
Model 50-DD



CONTACT WHEEL



IRREGULAR SHAPES



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USEFUL LITERATURE, CATALOGS, MANUALS

any of these technical publications may be obtained by circling the appropriate numbers on the Reader Service Cards, Pages 64-65

PROCESSES

Investment Castings: 154
Arwood Precision Casting Corp., 4-page bulletin. Important advantages of the investment casting process are discussed. Ten case histories where expensive production problems were solved by investment casting are given, and the company's complete casting facilities are described.

MATERIALS & EQUIPMENT

Hot Runner Blocks: 155
Detroit Mold Engineering Co., 4-page bulletin plus engineering data sheet. A recent issue of the company's "DME News" discusses the use of hot-runner blocks in large injection molds. Several photographs and a large schematic drawing illustrate the various appreaches to hot-runner mold design. Included is engineering data sheet No. 110 giving a table of core diameters for driven studs.

Sleeve Bearings: 156
Johnson Bronze Co., 110-page catalog. Catalog No. 56 gives complete information on the company's wide variety of bearings for industry. Also included are sections on alloy data and sleeve bearing design.

Mining, Smelting Facilities: 157
American Smelting & Refining Co., 28-page booklet. Originally published as a supplement to the company's 1956 annual report, this 4-color booklet contains more than 30 color and black and white photographs of ASARCO's mining, smelting, refining, and research operations. Detailed maps show the locations of the company's operations, as well as sales offices and other facilities.

Heat Treating Furnaces: 158
Surface Combustion Corp., 4-page bulletin. Bulletin SC-177 describes and illustrates the company's standard rated continuous heat treating furnaces. Included are specifications, process recommendations, and application examples for snap hearth, cast alloy link belt, and brazing furnaces.

Ultra-High Vacuum Valve: 159
Consolidated Electrodynamics Corp., Rochester Div. Bulletin P10-77 gives complete information on a new laboratory ultra-high vacuum valve for handling pressures of 10^{-10} mm Hg and lower. Designated the VAU-25, the valve is used in ultra-high vacuum systems where non-contamination and the ability to be baked out are highly important.

Safety Processing Products: 160
E. F. Houghton & Co., 4-page bulletin. Four processing products that reduce fire danger are described. Included are a high-flash solvent-type rust preventative, a cold cleaner to replace flammable solvents on production lines, a non-flammable hydraulic fluid, and a water-soluble reinforced cutting concentrate.

Die Casting Machines: 161
The Cleveland Automatic Machine Co., 8-page bulletin. Four models of the company's die casting machine line are described in a new bulletin. Important features and specifications are given on Models 50, 200, 400-N, and 600.

Crucible Installation, Maintenance: 162
Crucible Manufacturers Association, 4-page technical Leaflet. No. 8 in the association's series of leaflets on "Getting the Most from Crucible Melting" discusses proper care, installation, and maintenance of large capacity crucibles. Information is given on charging and melting in large crucibles, plus suggestions for proper cleaning.

Fire-Resistant Hydraulic Fluid: 163
Shell Oil Co., 4-page brochure. A lubricating oil-base fire-resistant hydraulic fluid is described. Illustrations show a flame test demonstrating the fluid's fire-snuffing ability, and its non-corrosive characteristics are discussed.

Refractories Applications: 164
Mexico Refractories Co., 24-page booklet. A new booklet describes the application of "Helspot," a high-grade clay blended with graphite and a special bonding agent. The sequence of illustrations follows the normal procedure and indicates where the product is routed.

Hydraulic Presses: 166
Loomis Engineering & Mfg. Co., Two specifications folders plus price lists. Bulletin 341B describes a 20-ton hydraulic bench press built for diversified and dependable laboratory and production work. Bulletin 232A describes a 25-ton hydraulic extrusion press designed for almost continuous production. Complete specifications and prices are included.

Alloy Stock Sheet: 167
WaiMet Alloys Co., Single-page bulletin plus stock list. A recent issue of the company's "Metals in Brief" discusses new developments in production of refractories and hardenable stainless steel. The accompanying stock list gives specifications of stainless steels and alloys available for shipment.

Nitrogen Generator: 168
Baker & Co., Inc., Instruments Div. A brochure has been issued which describes a recently-developed nitrogen generator with a wide controlled-hydrogen-content range. Safety features and economic advantages are discussed, and applications are described.

Vacuum System: 172
Consolidated Electrodynamics Corp., Rochester Div. Data Sheet No. 2-20 describes a new vacuum system for laboratory, pilot plant, and limited production use. Important features and applications are discussed, and a complete line of accessories is described.

Continued on page 60

Your Good Judgment is Confirmed When You Buy . . .

B&T DIE CASTING MACHINES

In many industrial centers you'll find leading die casters using B&T die casting machines — purchased by smart production men who, having carefully investigated and compared, choose them in preference to all others. These men know that for castings of extreme accuracy, excellent density and finish, B&T Die Casting Machines can not be beat. And, furthermore, that they'll give you top production with a minimum of maintenance.

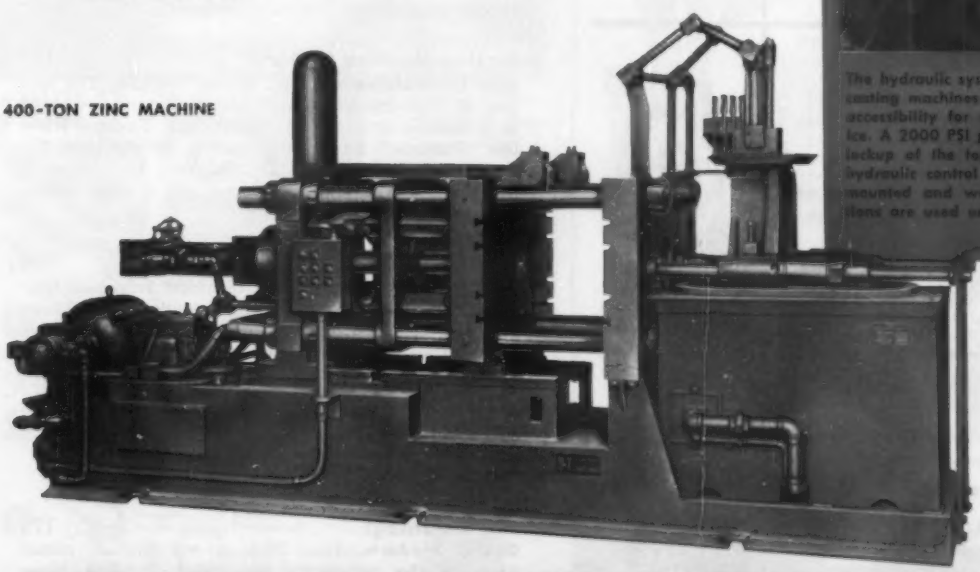
13 MODELS thoroughly proved by many years of actual service — ranging in capacity from 100 to 750 tons — for zinc, aluminum and brass. EACH DESIGNED AND BUILT TO THE SPECIFICATIONS OF PRACTICAL DIE CASTERS AND DEVELOPERS OF DIE CASTING MACHINES WITH OVER 35 YEARS OF EXPERIENCE.

FOR PRESSURE WHEN NEEDED 2000 PSI SYSTEM

FOR TOP PERFORMANCE *WITHOUT LEAKS!* MANIFOLD MOUNTED VALVES FLANGED PIPE CONNECTIONS

The hydraulic system on the B & T die casting machines stress simplicity and accessibility for adjustment and service. A 2000 PSI pump is used for final lockup of the toggle mechanism. The hydraulic control valves are manifold mounted and welded flange connections are used on pressure piping.

400-TON ZINC MACHINE



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Have you taken the four good steps?

How can cleaning costs be reduced 33% while cleaning quality is being improved? *See pages 7 and 8 in the booklet.*

What are four easy ways to improve the average rinse tank? *See page 10.*

What causes hydrogen embrittlement during electrocleaning? What is the remedy? *See pages 15 and 16.*

Do you need a brass cleaner that gives better protection against tarnishing?

Oakite has a new brass cleaner that provides scientific protection against the oxygen that tarnishes brass and other copper alloys during the application of reverse current.

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says a manufacturer who found that Oakite Composition No. 95 gave him:

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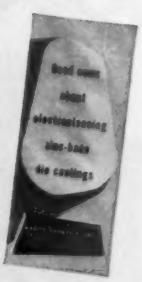

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Technical Service Representatives in Principal Cities of U. S. and Canada

For more information circle No. 92 on the Reader Service Card

Contact Pyrometer: **165**
Illinois Testing Laboratories, Inc., 12-page bulletin. Bulletin No. 4257 describes a hand-held portable pyrometer used for quick temperature readings of flat or curved, moving or stationary surfaces. A variety of uses are illustrated, and important features are discussed. Specifications, prices, and brief descriptions are also given of other pyrometer models made by the company.

Conversion Factors Chart: **169**
Precision Equipment Co., wall chart. A reference table in wall chart form includes common conversions such as inches to centimeters or watts to HP, as well as many conversions difficult to locate in reference manuals.

Stainless Steel Properties: **170**
Electric Steel Foundry Co., 10-page engineering report. The fifth in the company's series of "Alloy Notebooks" contains a report on the mechanical properties of castings made from 17-4 PH precipitation-hardening stainless steel. The booklet is illustrated with graphs, charts, and photomicrographs showing mechanical properties under varying production conditions.

Fluid Power Equipment: **173**
Modernair Corp., 4-page bulletin. The company's line of fluid power devices is described and illustrated. Included are various models of cylinders, valves, and packaged units. Also illustrated are three audio-visual fluid power educational aids developed by the company for in-plant education on the principles and proper applications of fluid power.

Die Casting Lubricants: **171**
Milwaukee Metalube Corp., 4-page bulletin. The company's line of lubricants especially formulated for the die casting industry is described. Complete information is given on different grades of die lubricants and plunger lubricants for either manual or force-feed system applications.

Induction Heating History: **199**
Ajax Electrothermic Corp., 18-page booklet. The history of high-frequency induction heating is presented in a booklet entitled "Dr. Northrup's 'Fireless-Wireless' Furnace." Early development by the late Dr. Edwin F. Northrup and Dr. Guilliam H. Clamer is described, and progress is traced into a wide variety of present-day applications.

Aluminum Corrosion Resistance: **174**
Reynolds Metals Co., 6-page technical reference brochure. Designed as a convenient guide to engineers, this two-color technical brochure makes extensive use of graphs which tell at a glance the yearly corrosion rate of more than 100 chemicals and other corrosive materials on aluminum.

FINISHING

Metal Cleaning: **179**
Oakite Products, Inc., 16-page bulletin. A recent issue of the company's publication "Oakite News Service" discusses several metal cleaning problems. A unique metal washing machine installation to speed production and conserve space is described.

Continued on page 63

For more information circle No. 97 on the Reader Service Card

Control Panels: 177
Kato Engineering Co., single-page bulletin. Form PAN-1156 describes the company's line of generator control panels. Both floor and wall mounted models are discussed and illustrated.

Belt Conveyor: 178
The Rapids-Standard Co., Inc., single-page bulletin. Form No. LPV-56 describes a light-duty cleated belt conveyor. Special features of the conveyor are diagrammed, and complete specifications are given.

Barrel Finishing Abrasives: 180
Norton Co., 8-page brochure. A new gate-fold brochure describes four abrasives for a wide variety of barrel finishing uses. Features of each abrasive are discussed and compared, and complete specifications are given.

Portable Electroplating Unit: 181
Sel-Rex Corp., Descriptive literature is available on a large capacity portable electroplating unit. Important design features of the new unit are described and illustrated.

Zinc Phosphating Compound: 182
Oakite Products, Inc. Full information is available on a zinc phosphating compound designed for use at low temperatures in spray washing machines. Advantages of the new compound are discussed.

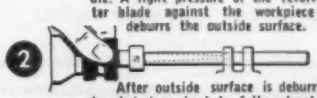
Steam Cleaning Equipment: 183
Turco Products, Inc., 4-page bulletin. A portable steam cleaning unit for a wide variety of applications is described and illustrated. Complete specifications are given, and a typical installation is discussed.

HOW TO....
DEBURR THESE INACCESSIBLE HOLE FACES BY MACHINE OPERATION with the amazing NOBUR TOOL

★FASTER
★EASIER

No more hand finishing methods for those hard-to-get-at inner surfaces on multi-wall parts. The NOBUR Tool with its double edge cutting blade does the job in seconds . . . all by machine operation. Can be used by anyone, with complete safety, on your own lathe, drill press, etc. Simple to operate.

1 Insert NOBUR tool in any machine spindle. A light pressure of the revolving cutter blade against the workpiece quickly deburrs the outside surface.



2 After outside surface is deburred, slide knurled sleeve back to fully retract the cutter-blade below pilot body diameter.

3 With cutter-blade retracted move workpiece or tool to position for deburring inside surface. Raise cutter-blade to deburr first one surface then the other.

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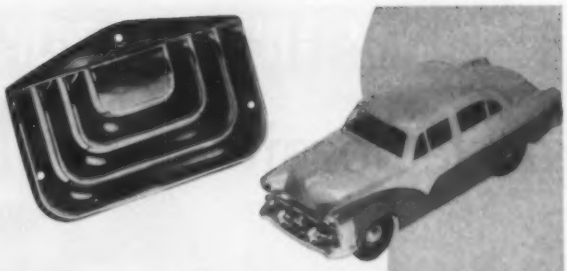

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you want best possible results
you want a minimum of rejections
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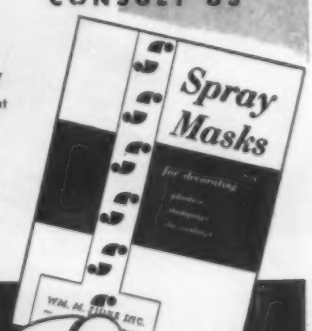
Send for your FREE copy of our 20-page book which shows the different types of masks and gives case-study illustrations of their use. Or send your samples and drawings for consultation and estimates.



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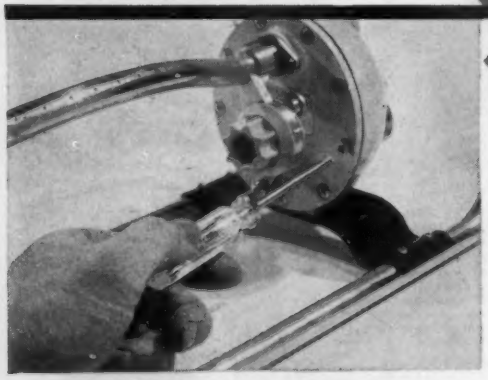
Because P-K Type A Self-tapping Screws have clean, deep slots and sharp gimlet points . . . and because they are consistently uniform, Reznor Mfg. Co. enjoys important savings in the assembly of their gas heaters.

To hold the plastic handle halves of their Instant Heat Soldering Irons together, The Lenk Mfg. Co. specifies P-K Type F Self-tapping Screws. No need for a separate tapping operation. Production is increased and costs reduced—thanks to P-K Screws.



Melnor Industries, Inc. (formerly Melnor Metal Products Co.) puts assembly strength into their famous "Swingin' Spray" oscillating lawn sprinkler by fastening zinc and aluminum parts with P-K Self-tapping Screws—7 Phillips Head Type Z and 18 Type F. They start right . . . drive right . . . and stay tight.

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For more information circle No. 101 on the Reader Service Card

Ultrasonic Inspection: 184

Curtiss-Wright Corp. Complete information is available on a method for ultrasonic inspection of castings with a self-contained, single-unit system. The "package" unit employs ultrasound reflections on the metal immersed in water to detect flaws.

Magnetic Particle Inspection: 185

Harry Miller Corp. A low-cost material for aqueous phase magnetic particle inspection of metal to detect flaws is described. The new product, designed to replace kerosene and mineral spirits, is said to give better definition of flaw and prevents rusting of the metal.

All-Purpose Jaw Clamps: 186

J & S Tool Co., Inc., single-page bulletin. Jaw clamps designed to eliminate U-clamps, straps, and fingers to secure work pieces on machine tools are described and illustrated. A "double action" locking principle is explained.

Adjustable Indicator Gauge: 187

Ellstrom, Inc., 4-page bulletin. Specifications, prices, and suggested applications for a new adjustable indicator gauge are listed. Three standard models are discussed. Illustrations show uses for checking cone shaped holes, blind holes, and shallow circular slots.

Tap Bushings, Driver: 188

Beaver Tool & Engineering Corp., 4-page technical bulletin. A new line of tap bushings which require no special drivers is described. Reductions in tooling costs and tap breakage are discussed.

You Can BY-PASS EXPENSIVE EQUIPMENT and LABOR COSTS

HIGH EQUIPMENT INVESTMENT → PHOSTEEM SAVINGS or HIGH LABOR COSTS!

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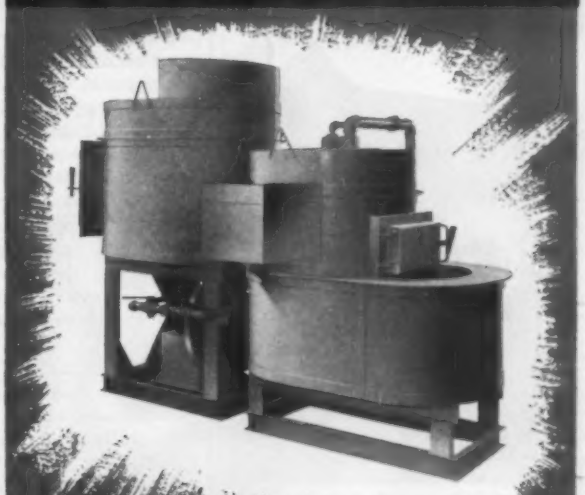
HERE'S ANOTHER NEW ONE!



Stroman "DC" Cylinder Type Furnaces for Combination Melting and Holding Aluminum with

CONTAINED COMBUSTION BURNERS

For Die Casting, Permanent Mold and Sand Casting Operations

"Versatility Plus" is the keynote of these newest Stroman Contained Combustion Furnaces. They are absolutely new in design for they incorporate Contained Combustion Burners which eliminate direct flame impingement on the metal. They also make for cooler working conditions because of less heat loss. They give greater fuel economy for less BTU input is required . . . Longest refractory life and least maintenance due to mild combustion conditions . . . Uniform heating condition and improved metal temperature control assure lowest metal losses.

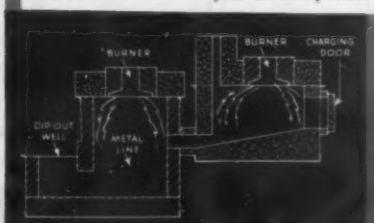
They are easy to charge and readily adaptable to automatic charging. Handling from 450 to 1600 lbs. per hour break down capacity with holding capacity from 600 to 2400 lbs., they will melt metal faster and more economically, and at the same time produce only the highest quality metal.

Roof of the furnaces are easily removed for furnace cleaning, relining, repair or burner service, as burner is mounted in the roof.

These Stroman "DC" Cylinder type furnaces are available in break down and holding combinations. However separate break down and holding units can be purchased. Break down units are often used to augment iron pot, electric and crucible furnace capacities.

Their flawless operation and ability to deliver years of trouble-free operation stamp them as a leading Stroman Aluminum production furnace. Investigate their cost cutting operation today.

Send for complete new catalogue No. 150 just off the press.



STROMAN FURNACE & ENGINEERING CO.

FRANKLIN PARK ILLINOIS

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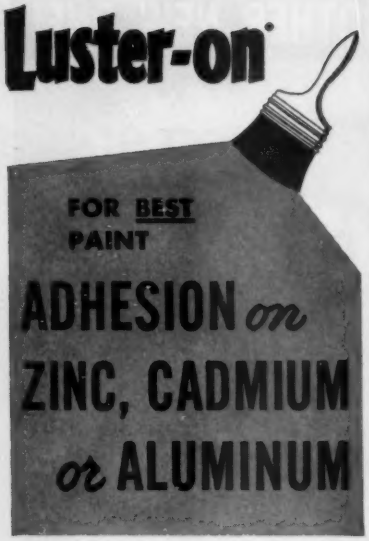
Luster-on



Long-time tests in the aviation and electrical appliance fields have proved that paint adhesion to surfaces treated with LUSTER-ON is superior to that found with other chromate conversion coatings. LUSTER-ON imparts a passive surface which offers corrosion protection and best adhesive base for paint.

LUSTER-ON MEANS ECONOMY

On zinc or cadmium — use *dilute* concentrations of LUSTER-ON utility liquids or *low* concentrations of LUSTER-ON 50 POWDER.

On aluminum — use *low* concentrations of LUSTER-ON ALUMINUM SEALER.

No current is required — no fumes to exhaust.

LUSTER-ON proved formulas offer excellent operating control

Superior treatment for zinc-base die castings, too!

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Circle No. 90 on the Reader Service Card

BRAZING FLUXES FOR CARBIDES INTRODUCED

Under normal conditions, no special materials or techniques are necessary to produce satisfactory joints when brazing carbides containing titanium, tantalum and tungsten combinations.

If, however, unusual conditions are encountered — such as long heating period, high temperatures or rebrazing, it is necessary to use a special flux, according to Fred J. Kelly, development engineer for General Electric's Metallurgical Products Department in Detroit.

The special flux, he says, should be one that will dissolve the oxides of titanium and tantalum generally formed under these conditions, a job that cannot be done with standard fluxes commonly used for silver brazing.

According to Kelly, two special proprietary fluxes to date have been found satisfactory when brazing under such unusual conditions. Both contain either silicon or born additives, which are strong oxides reducers — as well as the customary chemicals included in good fluxes.

It would be entirely satisfactory to use these brazing materials for all carbide tool brazing operations but, he cautions, their shelf life should be watched, since it is not as good as standard fluxes.

Consistently good brazes can be made with standard fluxes with induction heat, torch and furnace brazing — even under conditions which are not ideal. But if oxides are allowed to form, he says, it is not possible to produce satisfactory joints unless the special fluxes are employed.

NATIONAL LEAD SALES OFFICES COMBINED

Sales of metal and metal products of the Philadelphia Branch of National Lead Company are being consolidated into the Atlantic Branch (New York), under the management of George Sathre, manager, metal division, Atlantic Branch. Russell C. Kleinecke has been transferred from Pittsburgh to the Atlantic Branch as assistant to the manager, metal division. Both changes were effective January 1. Mr. Kleinecke will be located in Philadelphia, where he will supervise metal sales, as well as purchases of metal scrap, in that area.

A BETTER BACK-UP WHEEL

R57

FOR YOUR ABRASIVE BELTS

45° scoop tooth used for aggressive stock removal

NOW IN POPULAR 14" DIAMETER SIZES AT BIG SAVINGS

Now—new production techniques allow you to SAVE on new R-57 Rubber Contact Wheels! They have all the well-known features of R50 and R54 models — longer belt life, oil resistant rubber, wet or dry use, heat dissipation, maximum safety, etc. And what's more, they have a 30% trade-in value! (The R57, R50 and R54 wheels come in many popular sizes, ½" to 22" diameters in 1" to 6" widths, or to your specifications.)

14"

TYPE	WIDTH OF FACE 1"	2"	3"	4"
14" PLAIN	32.00	34.00	36.00	38.00
SERRATED	37.00	39.00	42.00	44.00

IN PLAIN OR SERRATED FACE IN ALL DUROMETERS

DEIta 6-8900

A WHEEL FOR EVERY OPERATION

45° Standard
Stock Removal
Slit Serration
Aggressive Contact Work
"X" Serration
Moderate Contour Work
Cosmo Expander
Operates Without Backstand Idler

CHICAGO RUBBER COMPANY, INC.
651 MARKET STREET • WAUKEGAN, ILLINOIS

For more information circle No. 91 on the Reader Service Card

NAME YOUR NEED

"Honite" Barrel Finishing Compounds fill it perfectly

"I need a fast cutter"

The fastest and cleanest cutting compound available is "HONITE" 392. With its aluminum oxide base and high foam action it is ideal for aggressive burring and surface cutting. High cushion provides good cleansing action. Mildly alkaline.

"HONITE" 392

One of the complete line of "HONITE" compounds

"I'm working with hard steel"

The best compound for long runs, especially on hard steel, is "HONITE" 332. It should also be used where a cleaning action is necessary. A coarse (180 mesh) silicon carbide abrasive base compound that cuts fast and long. Mildly alkaline.

"HONITE" 332

One of the complete line of "HONITE" compounds

"I want a fine finish"

For the very finest finish, the best compound to use is "HONITE" 334. A fine (600-1000 mesh) silicon carbide abrasive base, it's light colored, designed for long cycle use. Ideal for surface refinement and finishing to close tolerances. Mildly alkaline.

"HONITE" 334

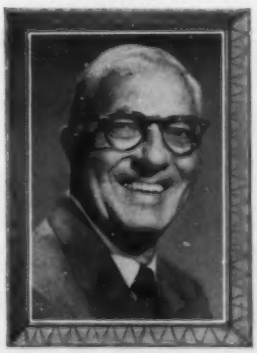
One of the complete line of "HONITE" compounds

"I need a dual purpose compound"

The best dual purpose compound—for surface cutting and fine finishing—is "HONITE" 302. Contains coarse abrasive for initial cut down which disintegrates into a mass of fine abrasive (-600 mesh). Gives an excellent semi-luster finish.

"HONITE" 302

One of the complete line of "HONITE" compounds



"I want cut, color and foam"

This unique combination of properties is found in "HONITE" 366, designed for surface cutting and polishing. Acts as a surface cutter for the first 4 or 5 hours then begins a coloring action *together* with strong foaming action. Mildly alkaline.

"HONITE" 366

One of the complete line of "HONITE" compounds

---WANT MORE INFORMATION?---

Minnesota Mining and Manufacturing Co.
Dept. FF-47, St. Paul 6, Minnesota

☐ Send me full information about "HONITE" barrel finishing compounds

☐ I'd like to talk with a "HONITE" Field Engineer

NAME.....TITLE.....

COMPANY.....

ADDRESS.....

CITY.....ZONE...STATE.....

Honite

Made in U.S.A. by MINNESOTA MINING AND MFG. CO. General Offices: St. Paul 6, Minn. In Canada: P.O. Box 757, London, Ontario. Export Sales Office: 99 Park Avenue, New York City.

PRODUCT OF 3M COMPANY RESEARCH

For more information circle No. 96 on the Reader Service Card

Plated under vacuum, these articles have a high-sheen surface that lasts as long as conventionally plated pieces.

Why plating
with vacuum
is easier and more profitable

Without buffing or polishing, without corrosive cleaning baths, without highly skilled help, you can now cover articles like those shown above with a shimmering finish that lasts for years.

All it takes is a CEC vacuum coater and some inexpensive lacquers to make metal and plastic articles look silver, gold, copper, or a multitude of other colors and tones.

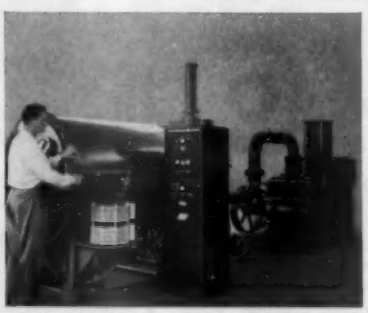
Vacuum-plating costs less. With a CEC vacuum coater you can plate thousands of pieces per day with unskilled labor.

New longer-lasting lacquers. There are on the market many lacquers which can make vacuum-plated articles wear as well as those plated in conventional ways.

The stayfast finish requires no retouching, or buffing, or polishing—just an easily applied coat of lacquer.

You can control film thickness easily and precisely. You can make surfaces electrically conductive *or* insulating as you wish.

For further information on this highly profitable process, write for information on the coaters, the lacquers, and the methods used.



1450 2½" diameter pieces per cycle, 3 to 6 cycles an hour—that's the production rate of this 48" CEC vacuum coater.

Consolidated Electrodynamics
Rochester Division, Rochester 3, N. Y.
formerly Consolidated Vacuum

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle No. 27 on the Reader Service Card

G-M TO BUILD NEW CASTING PLANT

General Motors plans to establish a new foundry for the manufacture of aluminum castings for automotive parts near Massena, New York, Harlow H. Curtice, president of General Motors, announced today.

Mr. Curtice disclosed that General Motors and Reynolds Metals Company have entered into an agreement under which Reynolds will provide aluminum from a reduction plant to be built in the same area.

Establishment of the plant follows approval by New York state officials of the proposal by the Reynolds Company for it to use electric power furnished by the Barnhart Island Power Station. Construction of this new station was recently approved by the New York State Power Authority.

Mr. Curtice said the proposed new plant is an addition to the announced substantial capital expenditures program of General Motors

"In view of the increased future requirements for aluminum in automobiles," he said, "we are proposing to erect this new aluminum foundry near the Reynolds reduction plant because of the operational advantages in having a foundry near an aluminum reduction plant. The aluminum can be transported directly in a molten state from the electro-lytic cells or "pots" to the foundry and poured immediately.

VANADIUM-ALLOYS SETS UP NEW DEPARTMENT

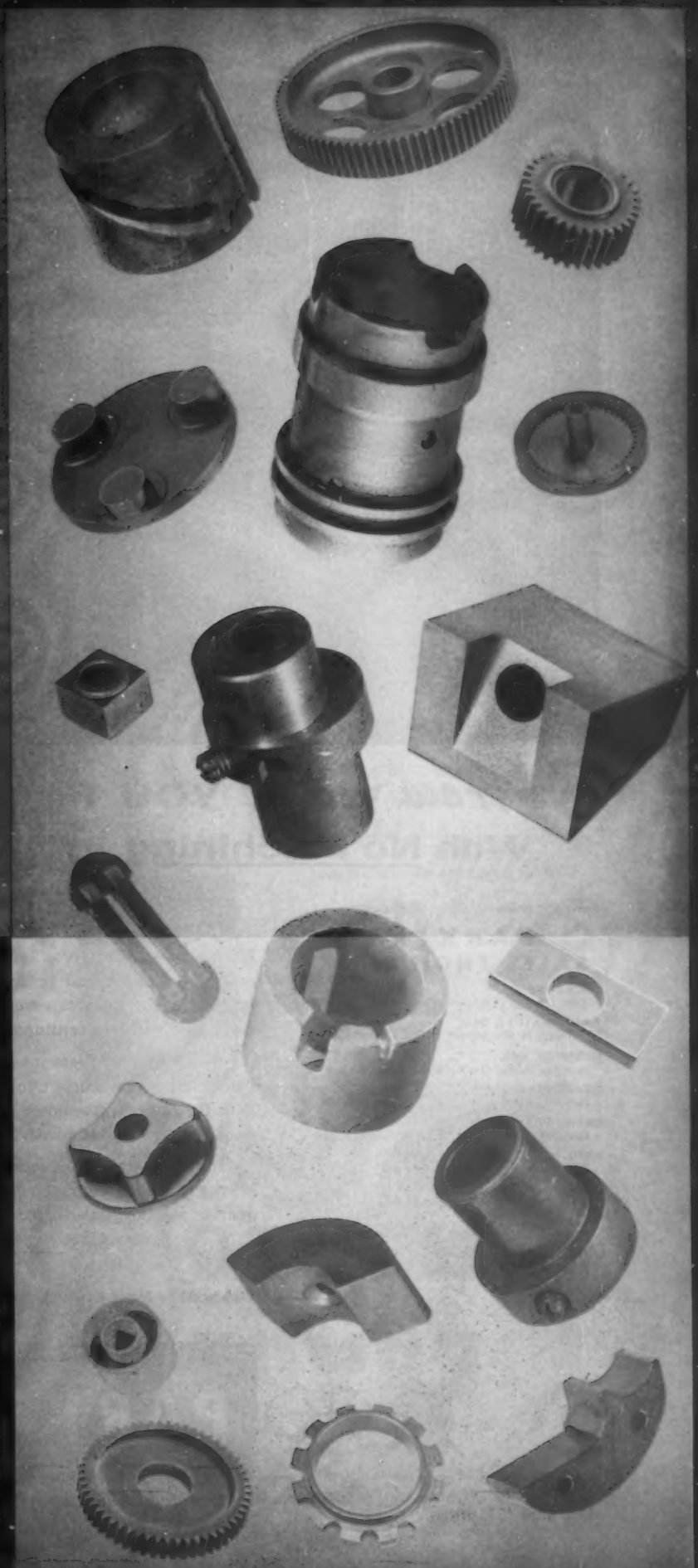
The Vanadium-Alloys Steel Company, to more effectively handle the metallurgical problems associated with the complexity of product development in today's expanding market, has announced the establishment of a Metallurgical Product Development Group.

Dr. George A. Roberts, Vice-President of Technology, made the announcement, stating the new group will be managed by Metallurgical Engineer, H. G. Johnstin. The Metallurgical Product Development Group, located at the main office in Latrobe, Pa., will be charged with the introduction and application of new tool steel products to industry. This work will involve the institution of in-plant test programs and the tabulation and evaluation of results.

PMM

6th annual

POWDER METALLURGY DIRECTORY

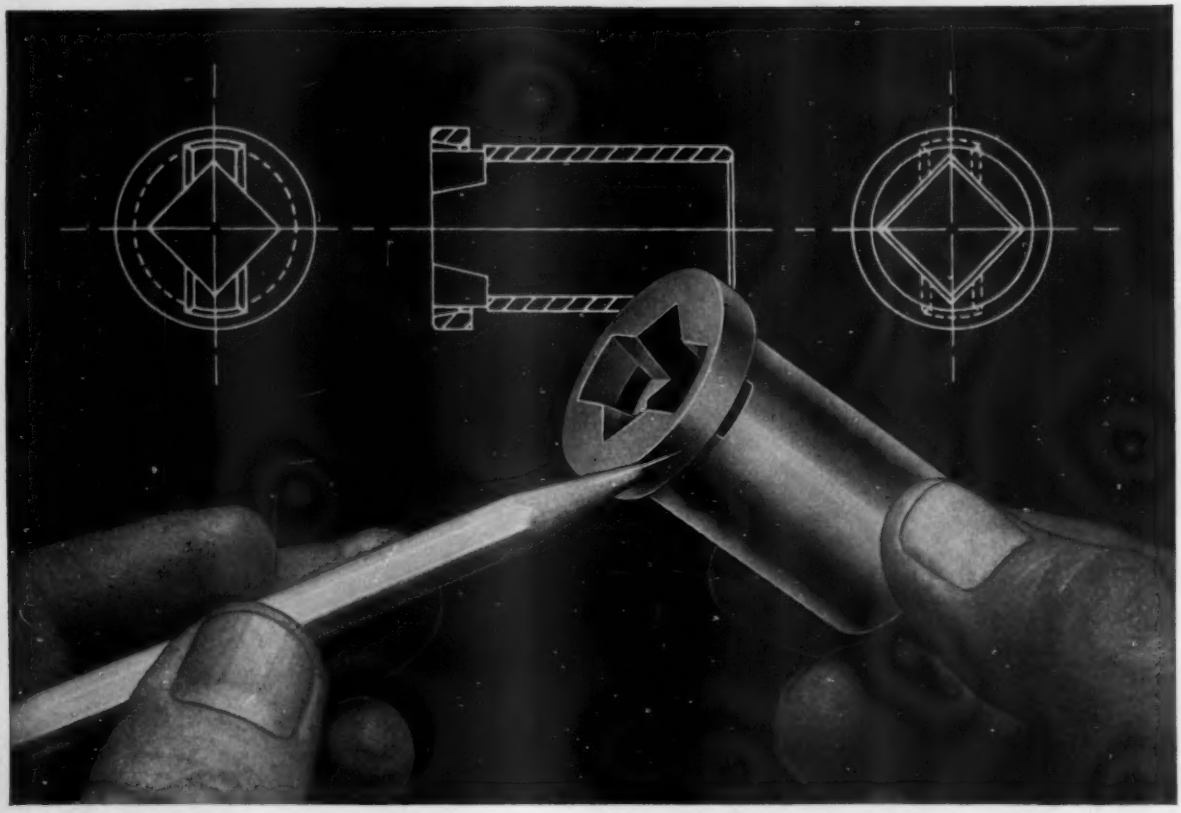


Section 1 • REFERENCE DATA

Section 2 • DIRECTORY

Section 3 • BUYERS' GUIDE

PRECISION METAL MOLDING • *April 1957*



How Would YOU Produce This Part With No Machining . . . No Scrap Metal?

PARKER SALES ENGINEERS

CHICAGO 49, Ill.
Ollie J. Berger Company • 2059 East 72 Street

CINCINNATI 14, Ohio
William H. Broxterman • 2430 Central Parkway

DETROIT 35, Mich.
Hodgson-Geisler Co. • 18917 James Couzens

GIRARD, Penna.
Daniel F. Marsh • 35 Chestnut Street

KIRKWOOD 22, Mo.
Edward F. Higgins, Jr. • 102 West Adams Street

WILTON, Conn.
Girard L. Palmer • Belden Hill Road

SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street

LONG BEACH 11, California
R. W. Fletcher, • 2803 Loomis Avenue

Can't be done? Parker did it . . . sharp internal corners, lateral holes, chamfers, flanged end and all . . . by fast, low-cost powdered metal pressing and sintering. No subsequent machining . . . no scrap-metal loss. Just think of the savings compared with conventional machining methods.

In addition to these inherent cost savings, Parker-engineered Powdered Metal Parts offer a wide choice of tensiles, ductility, density, impact resistance and other physicals. Tooling-up is done quickly and at relatively low cost.

It will pay you to check on the economies and design possibilities of Parker-engineered Powdered Metal Parts. Just call the nearest sales engineer listed here or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure ALUMINUM and ZINC die castings
POWDERED METAL PARTS

For more information circle No. 68 on the Reader Service Card

6th annual

POWDER METALLURGY DIRECTORY

WELL known to every metallurgist and designer is the fact that the properties of an iron casting seldom, if ever, are reflected in the properties determined on cast test bars. For any particular design, a correlation can be established and acceptance or rejection based upon test bar results.

To a great degree this same condition exists in the powder metallurgy field. Data that have been determined from test bars may or may not represent the true mechanical properties of a molded part of different shape. The data presented in the two tables of properties in Part I of this directory should, therefore, be used as indicative of the physical and mechanical properties of powdered metal compacts and not for rigid design purposes.

In many cases fabricators of metal powder parts will submit a block of sintered metal from which a part may be machined for testing. The same reservations concerning mechanical properties should apply in this case. A part machined from a block of sintered metal may not, and probably will not, represent the properties that will be secured when the piece under study is finally molded.

There have been no test methods or test bars evolved as yet that can take the place of close consultation, during design and specification, with a reliable fabricator of powdered metal parts. These men know how closely test bars and machined parts will approach the product they can make. Their advice should be carefully followed.

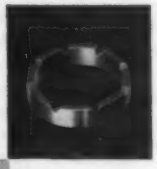
The listings in Parts II and III are accurate within the limits of the information supplied to us. In some cases incomplete information was furnished or the material supplied was not suitable for listing, hence certain material may be in error or entirely omitted.

a new expanded field of

BEARING DESIGN and APPLICATION

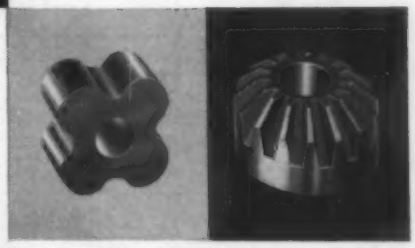
The inauguration of Bunting's new facility for engineering and manufacturing bearings and parts of Sintered Powdered Metals opens a wide new area of opportunity to all mechanical industry.

Sintered Powdered Metal Bearings and parts offer real economies in design. Bunting Engineering and manufacturing skill and traditional technical responsibility assure your most advantageous use of this material.



A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of both Cast Bronze and Sintered Powdered Metal Bearings and parts.

Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.



Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

For more information circle No. 15 on the Reader Service Card

Typical Properties of Powder Compacts

Composition							Density g/cc	Ultimate Tensile psi	Yield* Strength psi	Elongation % in 1"	Rockwell Hardness	Yield in comp.*
% Fe	% Cu	% C	% Sn	% Zn	% Ni	% Other						
COPPER BASE												
	100						8.0	20000		8		15000
	Bal.		5				7.3	20000		10		
	90-94		6-10				6.2	13000				13000
	90-94		6-10				7.0	25000				
	92		8				7.2	25000				
	88-92		8-12				6.2	14000	11000			
	88-92		8-12				6.7	16500	15000			
	90		10				6.4	14000		2-10	53H	11000
	90		10				6.6	14500		1.2-5	63H	
	90		10				7.5	40000				
	90		10				6.9-7.1	14-16700		6.8-7.1	60-70H	
	90		10				7.7-8.3	19-33600		8.9-15.6	45H-25B	
	89		9.75			1.25	6.6	14700			30-70H	32000
	89		9.75			1.25	6.3	12000			25-50H	26000
	87		9.5			3.5	6.6	15500			30-60H	37500
	87		9			4Pb	6.4	10000		4		
	89.5	0.5	10				6.4-6.8	15000			30H	
	87.5	1.5	10.5			0.5	6.4-6.8	12000				
	83-87	1.5	9.5-10.5			2.0-4.0Pb	6.4-6.8	12000				
	95.0	.5-2.0				3.0	5.8-6.2	15000		1.0		
	89	.5	10			.5	6.6-7.0	12000				
	82-88	1.75	9.5-10.5	.75	.35	2-4Pb	6.5	14000		2	53H	11000
	90			10			7.0-7.3	15-17300		3.5-6.1	30-70H	
	90			10			7.9	28000	11000			
	90			10			8.0	32000		18		34000
	85			15			7.3-7.6	16-20600		5.1-8.6	20-70H	
	85			15			7.85	35000		15		
	80			20			7.5	34100				
	80			20			7.8	30000				
	70			30			7.6	35000		13		
	90			10		.5P	7.9	30000		0.5		
	Bal.			20		1.5Pb	7.2	20000		10	45 (1)	15000
	78.5			20		1.5Pb	7.3-7.7	16-25900		5.2-9.1	25-80H	
	78.5			20		1.5Pb	7.5	21000		15	70H	12000
	78.5			20		1.5Pb	7.8	27000		10	85H	
25	65	(bal Zn. Sn., etc.)					6.2	16000		1	57H	14000
	75			16	(bal. Graph., Sn. etc.)		6.7	10000		2	50H	6000
	64			18	18		6.8	24000		6		
	64			18	18		7.3-7.7	19-22700		2.8-4.6	65H-30B	
	Bal.			18	18		7.2	14000		7	35 (1)	
	64			18	18		7.7	32000		10	92H	18000
	64			18	18		7.89	42000		14	84H	
IRON BASE												
100							5.7-6.2	14-25500		2.8-7	70H-40B	
100							5.9	12000			30-60H	79000(2)
100							7.0	35000		10	80	24000
100							6.4-6.8	21-28400		3.3-6.6	0-50B	
100							6.9-7.7	33-80900		3.8-12.3	20-90B	
99							5.7-6.1	14000			30H	
99							7.0					
98							7.5	10500		12		
98							7.7	13500		18		
100	(carburized and quenched)						5.7-6.2	31-57200			60-62C	
100	(carburized and quenched)						6.4-6.8	41-73100			60-62C	
100	(carburized and quenched)						7.0-7.7	69-84300			60-62C	

*0.1% Offset

Typical Properties of Metal Powders — Cont

Composition							Density g/cc	Ultimate Tensile psi	Yield* Strength psi	Elongation % in 1"	Rockwell Hardness	Yield in comp.*
% Fe	% Cu	% C	% Sn	% Zn	% Ni	% Other						
IRON BASE												
99.95						0.05	7-7.3	36200	24000	10		
99.95						0.05	7.5	60000	55000	5		
99.95			(carburized, light case)			0.05	7.0	95000		0		
99.95			(carburized, light case)			0.05	7.5	70000		2-4		
99.95			(carburized, light case)			0.05	7.3	78000		2		
99.95			(carburized, heavy case)			0.05	7.5	200000		0-1	62C	
99		0.8				Bal.	5.8	26000	25000	2.5		37000
98.5		1.5					6.1	24000		1	60	
99		0.5				0.5	5.7-6.1	15000				
99		0.5				0.5	6.1-7.3	20-50000				
99		1					5.8	15000				
99		1					6.4	32000				
98		.85					7.6	100000		8		
99.5						.5	8.0	21000		9-12		
Bal.	0.25-1.0						6.1	20-30000		.5-3	50	30000
Bal.	0.5						7.0	50000		5	140	80000
Bal.	0.5						7.0	120000		1	300	150000
97	3						6.1	25000			60	
95	5						5.4	18000		0.5	75H	25000
95	5						5.5	12000			25-60H	37000
95	5						5.6	20000				30000
95	5						6.2	48000				
94	5	0.5				0.5	5.8-6.2	40000				
92-98	2-8						5.4	16000				30000
92-98	2-8						5.7	20000				36000
Bal.	7						5.8	32000		0.5	60	32000
93	7						5.3-5.8	18-32500		1.2-2.0	0-50B	
93	7						5.8-6.2	23-35700		1.8-3.1	20-66B	
93	7						6.2-6.8	49-66400		1.9-2.2	30-76B	
92	8						5.5	32000				
87-93	8-13						5.9	40000				50000
90	9	0.7				Bal.	5.8	26000	25000	2.0	28B	40000
90	10						5.8	30000		0.5	94H	32000
89	10	0.5				0.5	5.8-6.2	30000				
90	10						6.1	30000			80-100H	81000(2)
90	10						6.2	29000		0.9	55F	
89	10	0.9				Bal.	6.2	40000	36000	2.0	34B	54000
Bal.	10-15						5.8-6.2	30000			80H	
85-90	10-15	0.5				0.5	7.2-7.6	60-100000				
85	15						6.2	32000		3	90	
Bal.	15-20						5.8-6.2	30000			70H	
Bal.	20					0.5	6.4	40000		1	140	75000
80	20						6.4-6.8	27-44200		1.3-2.1	30H-10B	
Bal.	20					0.5	7.4	75000		1	83	95000
78	20	0.8				Bal.	7.4	75000	69000	2.0	85B	70000
80	20		(Infiltrated)				7.6-8.2	66-100200		3.0-5.2	50-100B	
80	20		(carburized and quenched, infiltrated)				7.6-8.2	98-147800			60-62C	
Bal.	25						5.8	25000		1	45	30000
75	25		(copper impregnated)				6.2	34000		4	90	
74	25		(Infiltrated)				7.1-7.6	75000			65B	
72	25		(Infiltrated)				7.4	60000		3	70B	
75	25		(Infiltrated)				7.5	65000		1.5	75B	70000
74	25		(Infiltrated and Carbonitrided)				7.1-7.6	80000			90B	
Bal.	5.0					3.0	5.8-6.2	13000		1.3	30	
Bal.	10.0					3.0	5.8-6.2	30000			45	
Bal.	20.0					3.0	5.8-6.2	30000		1.0	45	
Bal.		0.3			1.5	0.45 Mn 0.20 Mo	7.5	115000	85000	1.5	30C	80000
Bal.					8	18 Cr	6.4	40000		7	50	45000
97		1				2	6.7	70000				
90		1				9	7.3	75000				

*0.1% Offset

SECTION 1

Designing For

IS IT SUITABLE FOR POWDER METALLURGY METHODS?

I. A CHECK LIST FOR DESIGNERS

	Yes	No
1. Is the projected area within commercial press capacities?	____	____
2. Is the ratio of height to effective diameter 4:1 or less?	____	____
3. Have unmoldable flanges, projections and undercuts been eliminated from the molding drawing?	____	____
4. Is the ratio of depth to diameter of cored holes within molding limits?	____	____
5. Has adequate taper been allowed on cored holes?	____	____
6. Have very small holes been specified as drilled, not cored?	____	____
7. Have corners been given an adequate radius?	____	____
8. Are adequate fillets provided?	____	____
9. Have tolerances been "loosened" as much as possible?	____	____
10. Will coining be required to meet some dimensional tolerances?	____	____
11. Are the mechanical properties specified realistic or can they be lowered?	____	____
12. Are all physical requirements clearly specified?	____	____
13. Has surface finish been specified?	____	____
14. If any special properties are needed, have they been specified?	____	____
15. Has heat-treatment been specified?	____	____
16. Has the feasibility been confirmed by a powdered metal fabricator?	____	____

II. A COSTING BALANCE SHEET

	Non-powder methods	Powder methods
Initial tooling	$____	$____
Raw materials	____	____
Jiggs & fixtures for second operations	____	____
Raw material stocking	____	____
Total machining costs	____	____ (1)
Finished material stocking	____	____
Cost of maintaining inventories	____	____ (2)
Incoming material inspection	____	____
Intermediate inspections	____	____ (3)
Second operations	____ (4)	____ (5)
Heat treating	____	____ (6)
Surface finishing	____	____
Capital expenditures	____ (7)	____
Assembly costs	____	____
Scrap losses	____	____ (8)
Final inspection	____	____
Total costs less general overhead	$____ (9)	$____ (9)

(1) This applies only to non-powder methods of fabrication.
(2) If finished parts go directly to assembly this is not a cost item.
(3) If no second machining operations are performed there will not be an intermediate inspection.
(4) For non-powder parts, this is included in total machining costs.
(5) In many cases the powdered metal fabricator will do some or all of the second operations.
(6) Whenever possible the heat treating is done by the powdered metal fabricator.
(7) This includes tools, buildings, etc. on which depreciation and tax deductions are taken.
(8) When no second operations are done, this may not be an item.
(9) Total costs must always be compared at exactly the same level of completion. Generally at assembly level or at final product level.

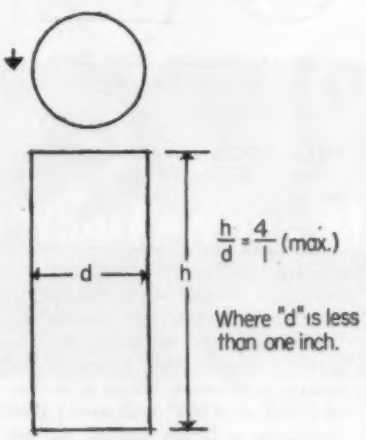
Powder Metallurgy Fabrication

WHEN the designer evaluates the possibility of converting from some stereotyped method of manufacture, such as machining or sand casting, to powder metallurgy as a method of fabricating, there are a number of factors to be considered if a fair appraisal is to be made. Broadly, the problem must be considered in two phases, either of which may be the determining factor. These are: CAN IT BE MOLDED, and HOW DO COSTS COMPARE?

CAN IT BE MOLDED?

1. What is the Projected Area? — Since powder metallurgy is essentially a mass-production high-speed process, the normally installed presses (and furnaces) are limited in capacity and size to those units which can operate at relatively high speeds. Probably a majority of the structural parts made are pressed at less than 40 tons per square inch, which limits the total area which can be handled to about four or five inches. The size of the die block which can be installed in the press is a further limiting factor. Since the majority of powder metal presses now in use require that the forming die be inset into the press table, the design of the press may again limit the size of the piece. This factor, however, often can be resolved by inquiry among the various fabricators to locate one or more who have equipment capable of pressing out-sized parts.

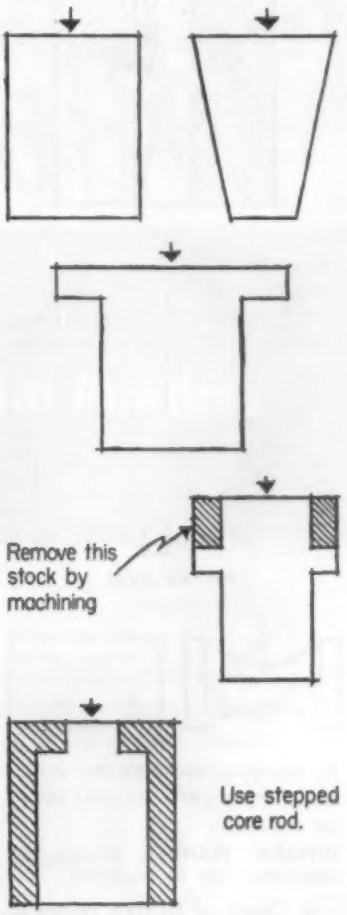
2. The Ratio of Height to Effective Diameter — Contrary to popular belief, the transmission of pressure through a powder mass is not hydrodynamic. Interparticle friction and wall friction cause serious departures from fluid flow, and as the loose powder is compacted, the transmission of pressure through the part becomes less like a liquid and more like a solid. This flow factor, plus, again, certain bounds imposed by press design, places a practical limitation on the length of the part (that is, parallel to the direction of applied pressure) that can be made. A good rule of thumb is that the ratio of height to effective diameter be not more than 4:1 for parts less than one inch in diameter, and considerably less than this ratio as the diameter increases.



MAXIMUM height to diameter ratio.

3. Flanges and Other Projections — In general, powdered metal parts should be designed either with straight walls, or with the larger end up if curved or tapered. Where a flange or other projection must be employed, it should always be at the top of the part so that ejection from the bottom can be accomplished. Where a flange must be included below the top of the piece, the part should be molded in such a manner that the flange can be formed by machining.

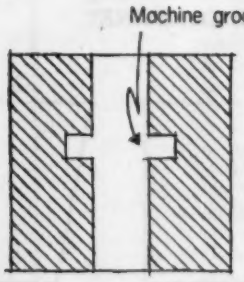
4. Undercuts — Except in very rare cases, undercuts should not be formed during pressing operations. While shallow undercuts and re-entrant angles can be formed during pressing, the tooling for such jobs always is

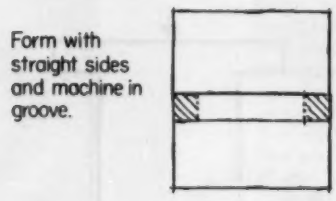


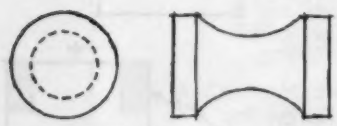
Arrows indicate direction of applied pressure.

FLANGES and projections must be at the end of the part or machined in.

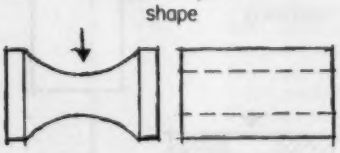
extremely expensive, and is seldom justified. Under some conditions powders can be made to flow into shallow cavities in the upper punch so that difficult shapes can be molded, but these should be avoided whenever possible.







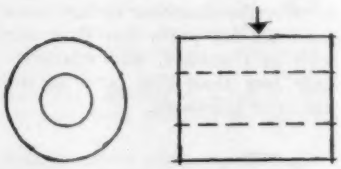
Machine spool shape



By applying pressure in direction shown, this part can be molded.

INTERNAL FLANGES, grooves and undercuts must be machined.

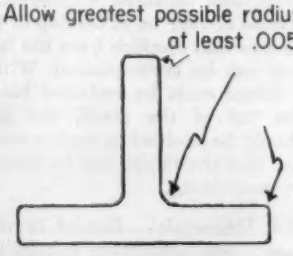
5. Cored vs. Drilled Holes — Holes as small as 0.050″ can be cored if they are short. With small diameter core rods, breakage rates are exceptionally high unless the ratio of length to diameter is held to about 1:1. On larger diameters—above approximately ¼″—this ratio of length to diameter can be increased to about 4:1. Generally no taper is required on short holes. However, as the length of the hole increases, a taper must be allowed. This taper is not great, generally less than 1°. In many cases where holes cannot be cored, it is possible to center spot so that drill jigs are not required. Where extreme precision of location or diameter of a hole is required, it is generally better to drill or bore after the piece has been pressed and sintered. While parts occasionally are molded where the center-to-center distance between cored holes is held to very small tolerances, such pieces are always very expensive and a detailed study of machining costs should be made before such tolerances are specified.



Holes in direction other than parallel to direction of pressure must be drilled.

SMALL HOLES and those not in the direction of applied pressure must be drilled.

6. Radii and Fillets — Powdered metal parts with sharp corners or edges should never be specified. There will almost invariably be chipping and breakage on external corners and edges if no radius is allowed. While a radius as small as 0.005″ will avoid this breakage, a larger radius should be allowed whenever possible. On internal corners a fillet with a minimum radius of 0.005″, and preferably more, should be provided. Sharp corners act as stress concentration points and will cause undue part failure. Even with a lubricant, metal powders are abrasive and a sharp corner or edge on a die or punch soon becomes rounded. Exceptionally high tool maintenance results if a radius is not allowed.



RADII and fillets must be generous to prevent failure and chipping.

7. Second Operations vs. Molding — Before finalizing a design for powder metallurgical manufacture, a thorough study of both possible and probable machining operations should be made. In many cases a substantial saving in manufacturing costs can be effected by making a part as nearly complete as possible by powder metallurgy, and then completing the work with standard machining operations. Simple turning, drilling, boring, and grinding generally are inexpensive operations. On the other hand, milling is one of the most expensive machining operations, and whenever possible the parts should be molded to preclude milling operations later. It should be remembered that all the normal machining operations possible on wrought stock can be performed also on parts made from metal powders. Carbide tooling generally is preferred for cutting these materials. Slight differences in the manner in which the tools are ground will be necessary, but generally no difficulties will be encountered in machining or grinding powder parts.

8. Required Dimensional Accuracy — Probably too many designers tend to specify dimensional tolerances which are far more rigid than actually are required for the proper functioning of a part. There will be a very great difference in price between a part with tolerances of, for instance, ±0.005 to ±0.006, and a part with one-half or one-fifth of such tolerances. In many cases this difference can amount to several hundred percent, and may make the manufacture of the part by powder techniques either mechanically or economically impossible. Where close tolerances are called for on a part made from metal powders, coining the piece is almost always necessary after pressing and sintering, which increases costs substantially. Not only will the piece costs be greatly increased, but the tooling costs probably will be almost double, since two complete sets of forming tools will have to be built. This increase in initial tool

Continued on page 76

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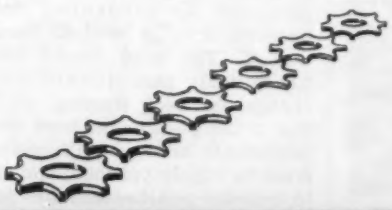
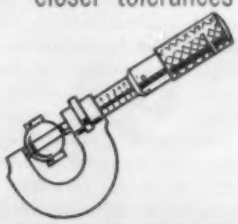
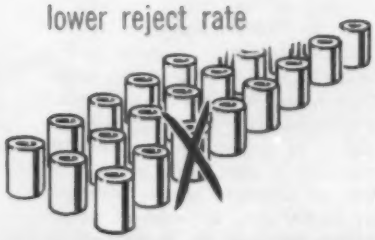


closer tolerances



lower reject rate



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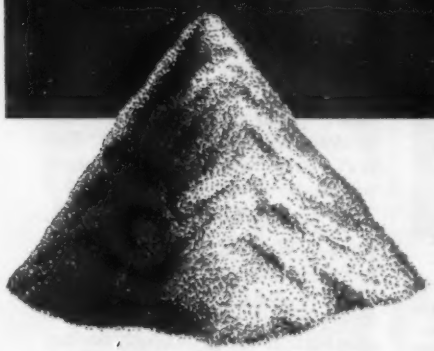

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costs will be accompanied by a much higher tool maintenance cost, which may be a direct charge or may be reflected in the piece cost. Another point to consider is that forming to close tolerances does not give much latitude for tool wear, with the result that replacement must be more frequent, or initial costs must be higher.

9. Actual Physical and Mechanical Strengths — Designers who are accustomed to working with wrought steels may continue to specify the same mechanical and physical properties in powdered metal parts even though these properties are far in excess of service requirements. It is for just this reason that many pieces that could, and should, be made from metal powders are still being machined from wrought stock. There is seldom any reason to machine a part from stock that has an ultimate tensile strength of 50,000 psi, a yield of about 30,000 psi, and an elongation of 22%, when a powder part having a tensile strength of 20,000 psi, a yield of 15,000 psi, and 0% elongation would do the job equally well and cost a fraction as much to produce. While this example may be extreme, it does point up that a part should be designed for service requirements, and not be over-designed, with a consequent increase in cost. On the other hand, the improper use of powdered metal parts can lead to under-design, which results in part failure and can create a feeling of distrust for powder parts in all applications.

10. Special Properties — Many of the special properties of powdered metal parts are well known to the average designer. Self-lubricating bushings, cemented carbides, heavy metal, and a few others are so well known that they need no further discussion. Less well known, however, is the ability of powder metallurgy to combine into a homogeneous mixture metals, or metals and non-metals, which are completely insoluble in each other in the liquid state. Such mixtures may have unique properties of special value in a given design and no other method of preparation will produce them. However, before such mixtures are specified, competent powder metallurgists should be consulted to determine the practicability of manufacture.

11. Surface Hardenability — Unless given special treatment, the average part produced from metal powders is liable to be both porous and soft. For some applications, such as gears, cams, dogs, and other wear parts, it may be necessary to have a harder surface than is normally produced. For these parts, case-carburization is the common practice. This can be accomplished either by pack or by gas carburizing procedures. In some cases salt baths are used. However the natural porosity of the powdered compact makes this procedure of dubious value, since salt may be entrapped in the pores, causing later corrosion. Compacts which have been infiltrated with copper are completely non-porous, so that any normal method of carburizing may be used. Another possible method of achieving the same result is to specify the part from a low-alloy steel powder. A number of these powders are available, and parts made from them can be heat-treated in much the normal manner for alloys of the particular composition. These alloy steel powders are somewhat more expensive than straight iron powder, so that the per-piece cost will be higher. Because of the somewhat higher hardness of these powders, it should be anticipated that tool life will be shortened.

12. Surface Finishing — One of the more controversial subjects in powder metallurgy is surface finishing. It is probably that a very great majority of powder parts are used without any finish at all. They can, however, be painted most satisfactorily, and they can be "plated" very successfully either by vacuum plating processes or by vapor plating methods. Steam treating produces a corrosion resistant surface which stands up well under a wide variety of atmospheric conditions. Normal electroplating or any other finishing process involving immersion of the parts in a liquid generally is dangerous, since both the liquid and dissolved salts may be entrapped in the porous structure, causing difficulties later. Impregnation with any of the several different materials can adequately seal the pores. Impregnation or infiltration with copper or brass may be employed, but this procedure is expensive and seldom justified if the only object is to secure a non-porous surface. Some users of powdered metal parts report success in plating if the surface of the part is "peened" to close surface porosity. This method may work, but the possibility of imperfect sealing and consequent entrapment is rather great. Parts specified as high density—that is, around 95% of theoretical density—can be handled in almost every case like wrought material.

HOW MUCH WILL IT COST?

1. Tooling for Powder Metallurgy — Generally speaking, tools for forming metal powders are expensive. They must be made of a very good grade of tool steel, generally a high-carbon high-chromium air-hardening steel, hardenable to at least 63 Rockwell C. The steel should have practically zero dimensional change on heat treating or, if this is not possible, at least very predictable changes. All tooling must be highly polished, and the fit between punches and dies and core rods must be very close to prevent formation of flash and the entry of powder particles, with consequent galling. It is impossible to predict the life of this tooling, but for very long runs or when higher than usual forming pressures are used, it is advisable to use cemented carbides for wear surfaces wherever possible. The customer who pays for the initial tools owns such tools. Tool maintenance and replacement, when necessary, generally is done by the fabricator. This may vary with different companies, however.

2. Tooling for Second Operations — Well designed powdered metal parts will require only simple machining operations. Every effort should be made to eliminate milling. Drilling, boring, grinding, reaming, and simple turning are low-cost operations. Their use as second operations is justified if simplification and lower cost powder tooling results. However, the cost of all second operations must be known in advance, or closely estimated, so that a realistic appraisal can be made.

3. Jigs and Fixtures Not Required — A relatively large cost item in the manufacture of a part may be the jigs and fixtures required for standard machining operations. Elimination of these

tooling items represents one of the cost saving items which must be credited to powder metallurgy. On the other hand, the cost of any jigs and fixtures needed for second machining operations must be added to the cost of the powdered metal fabricating process.

4. Cost of Stocking Raw Materials — When powder metallurgy is used as a fabricating method, there is no need to stock raw material, either rough castings or wrought stock, and the rental value of the floor space released is a cost item to be evaluated. In this connection there may also be a measurable labor saving and a transportation saving from dock to storage to the work floor. While some of these items are difficult to evaluate in dollars, they are, nevertheless, very real expense items.

5. Inventory Reduction — In order for production to proceed at a reasonable rate and without undue delays, it is necessary to maintain a stock of materials, raw, finished, and perhaps semi-finished, at all times. Mention has been made of the probably savings that will result from not having to stock raw materials and semi-finished components. In this same category is the maintenance of inventories. Here the savings that may accrue are usually in office time. Through the elimination of manufacturing step, purchasing is simplified, and the clerical time required to maintain inventory records, as well as the actual taking of the inventory, is saved. Again this saving, while very real, is one which may be difficult to evaluate in some companies, but it represents man-hours of clerical labor spent or saved, and must be accounted for.

6. Inspection Reduction — When manufacture starts with either a rough formed part or with wrought stock, plural inspection is essential. The incoming stock must be inspected when received, one or more inspections are essential during manufacturing operations, and finally the finished part must be inspected. In most cases, all but one of these inspections are eliminated when a powered metal part is used. The incoming parts are inspected and are then ready to go either into assembly or into storage; all intermediate inspections are eliminated, with a consequent saving.

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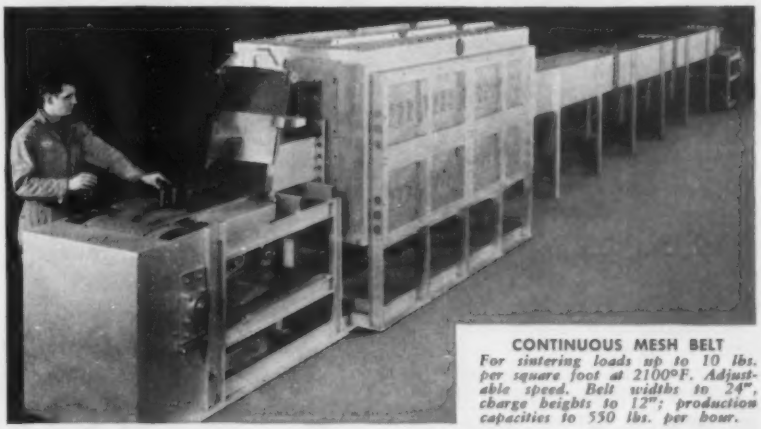

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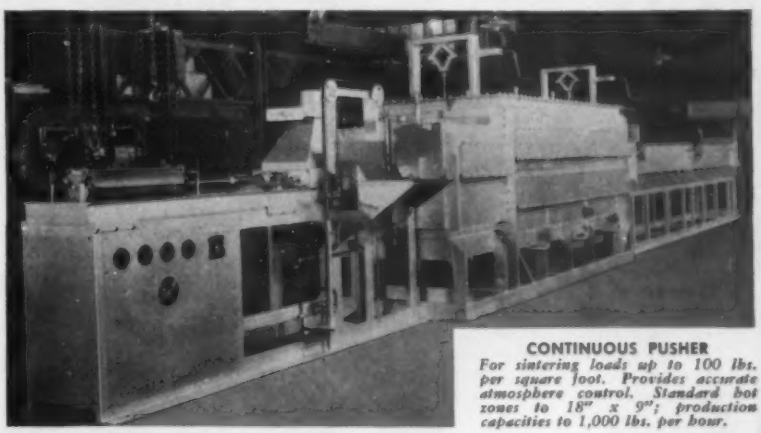

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7. Scrap Losses — One of the outstanding cost saving features of powder metallurgy is the reduction in scrap losses. With sand castings, for example, it is not unusual to have a high scrap loss due to unsound or otherwise unusable castings. If any appreciable amount of machining is done, there is always the possibility of scrapped parts due to machining errors. Finally, whenever metal is removed, there is a scrap loss due to the chips, shavings, grinding, etc., generated by the machining operations. In this connection, in addition to the actual metal loss there is the expense of collecting and disposing of the machining scrap—in other words, the housekeeping costs. All of these factors are direct charges which are accurately known in any well run shop.

8. Capital Expenditures — Particularly in the case of a new product, a considerable capital investment in machines and buildings may be required. Any portion of such an investment that can be saved by having parts fabricated from metal powders is, therefore, a direct dollar saving, reflected in the cost of manufacture. But new products are not the only reasons for spending money on machines and buildings. Increased volume of business can place such a load on existing facilities that they must be expanded. In this respect there is one factor often overlooked by management. When a new product is born, or when volume of manufacture increases, it is logical to examine manufacturing methods to determine where direct savings can be made. But consider the case of the birth or expansion of a product that cannot utilize powder metal parts in any manner. This product will require machine and machine operator time. By a critical cost analysis of other and possibly totally unrelated products, conversion to powder metallurgy can, and often does, release men and machines for other work, thus avoiding the purchase of machines, the hiring of additional workers, and possibly plant expansion. It can even be true that the cost of the powdered metal part is greater than some other method of fabrication, but the over-all company saving will be sufficiently large to justify the conversion to the powdered metal part.

It is now possible to draw up a balance sheet that will show whether or not a given part should or should not be made from metal powders. Such a balance sheet would start with a few determinable assumptions:

1. A design has been worked out which is functionally correct and can be made by powder techniques.
2. The *real* mechanical and physical requirements of the piece are known and can be met by a powder part.
3. The dimensional tolerances called for are as liberal as possible for proper functioning.
4. Essential surface finishing operations can be performed on the part made from metal powders.
5. The metal powder fabricator(s) have been given sufficient information and specifications so that their quotations can stand.
6. A competent fabricator has been consulted who has helped to finalize the design and specifications.

The balance sheet to evaluate the different manufacturing methods might be set up something like Table I.

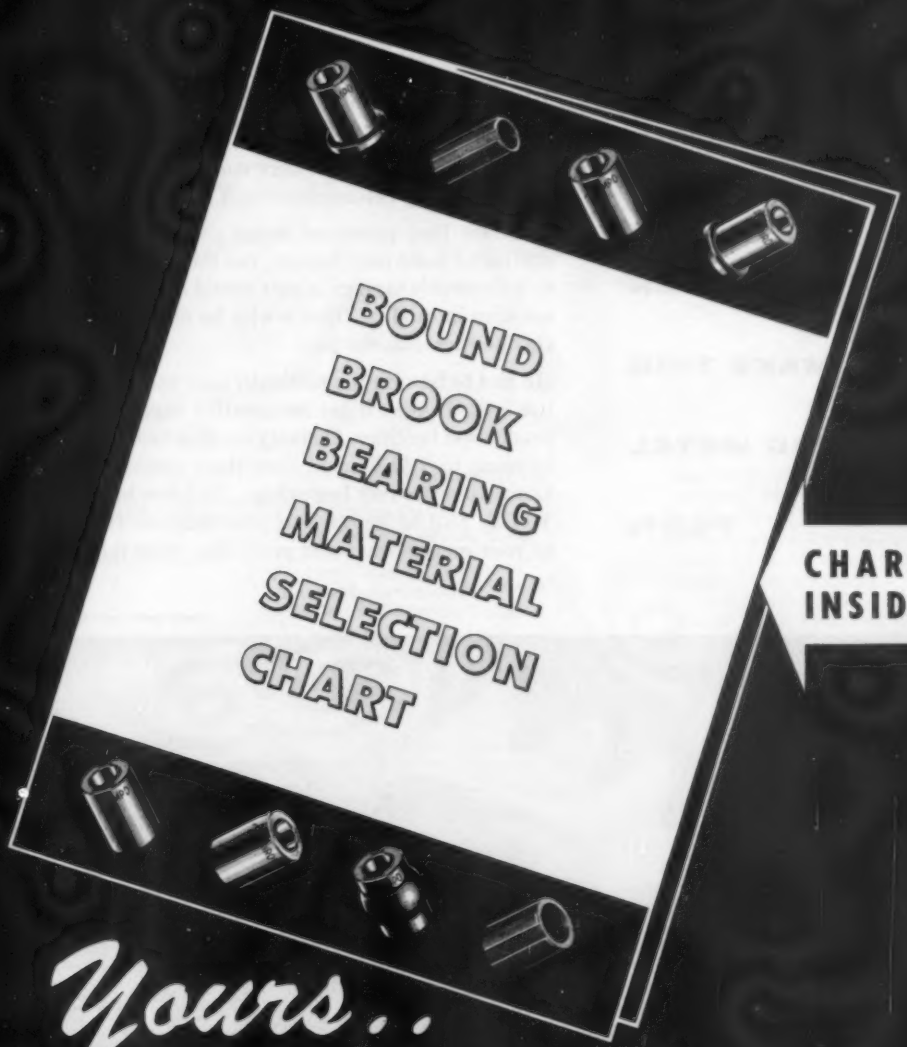
TABLE I

Costs per 1000 pieces for part No. XB-142

Cost Item	By Non-Powder Methods	By Powder Methods
Initial tooling	$	$
Raw materials	$	-
Jigs & fixtures for second operations	-	$
Raw material stocking	$	-
Total machining costs	$	-
Finished material stocking	$	$
Cost of maintaining inventories	$	$(1)
Incoming material inspection	$	-
Intermediate inspections	$	$(2)
Second operations	-(3)	$(4)
Heat treating	$	$(5)
Surface finishing	$	$
Capital expenditures	$(6)	-
Assembly costs	$	$
Scrap losses	$	-(7)
Final inspection	$	$
Total costs	$(8)	$(8)

Notes:
(1) This may not be an item when finished parts are delivered and go directly into assembly. With intermediate or second operations stocking of semi-finished and finished parts probably will be essential.
(2) If no second operations are performed, there will be no intermediate inspections on powder parts.
(3) For non-powder parts this item is included in total machining costs.
(4) Even when there are several machining operations to be done, many fabricators of powdered metal parts prefer to do them and deliver a complete piece. This item may, therefore, be eliminated in some cases.
(5) In most cases heat treating is done by the fabricator, hence this item may not be chargeable separately.
(6) This includes tools, buildings, etc. on which depreciation and tax deductions are taken.
(7) This no cost assumes that there are no second machining operations. If these operations are done, there will be some scrap losses.
(8) Total costs must always be figured at the same level of completion. If the comparison is made on a semi-finished product, it must be where all subsequent operations are common to parts made by all of the different methods being compared.

From the foregoing, it is amply clear that there are many factors to be considered when a change to powder metallurgy as a fabricating method is considered. It is true that in some establishments the accounting practices are such that a complete cost accounting per part, as defined here, is not possible. It is also true that some of the individual costs enumerated above are frequently lumped in general overhead. Unfortunately there can be only one answer to these cases, and that is that incomplete accounting practices are being followed. IT IS NOT SUFFICIENT TO KNOW THAT AN OVER-ALL PROFIT OR LOSS OCCURS. It is essential that the exact cost of every part or component of the product being made be known. Only in this way is an accurate evaluation of manufacturing methods and procedures possible, and the benefits that accrue from powder metallurgy be realized.



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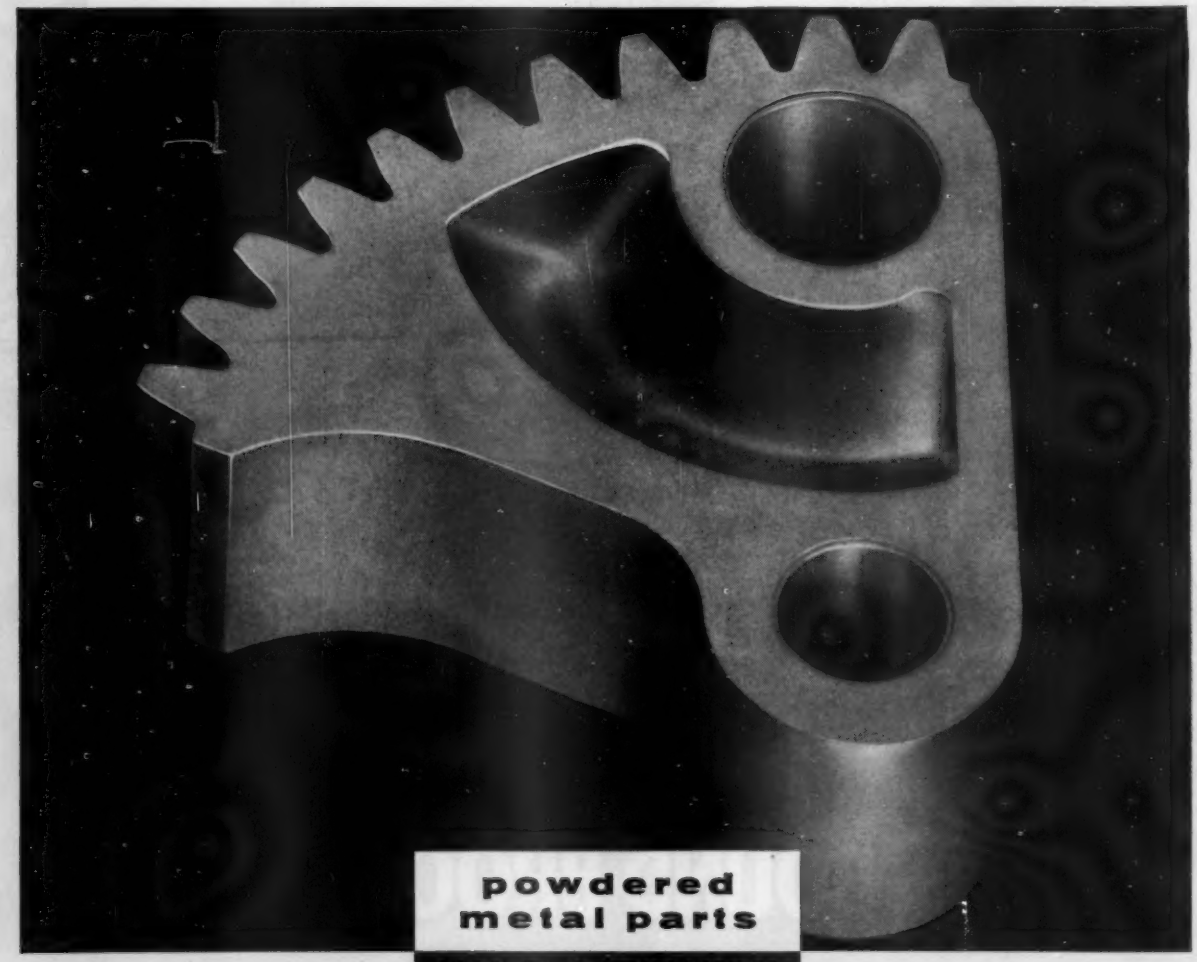

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Ford Motor Co.
Accessory Div.
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
General Sintering Corp.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
Johnson Bronze Co.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
Metal Powder Products, Inc.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
National Molded Products, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Picco Industries
Powder Metal Products, Inc.
Powdercraft Corp.
Precision Metal Products Co.
Presmet Corp., The
Pure Carbon Co., Inc.
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Symmco, Inc.
Wakefield Bearing Corp.
Western Sintering Co.
Wicks Corp., The
The United States Graphite Co. Div.
Yale & Towne Mfg. Co., The
Powdered Metal Products Div.

Iron Base

Allied Products Corp.
Powdered Metal Parts Div.
American Powdered Metals, Inc.
American Sinteel Corp.
Arrow Sintered Products Co.
Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Brockway Pressed Metals, Inc.
Bunting Brass & Bronze Co., The
Carbon City Products Co., Inc.
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Clevite Corp.
Compacted Metals Corp.
Deva-Metal Corp.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
Ford Motor Co.
Accessory Div.
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
General Sintering Corp.
Globe Industries, Inc.
Supermet Div.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
Johnson Bronze Co.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
Metal Powder Products, Inc.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
National Molded Products, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Picco Industries
Powder Metal Products, Inc.
Powdercraft Corp.
Precision Metal Products Co.
Presmet Corp., The
Pure Carbon Co., Inc.
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Symmco, Inc.
Wakefield Bearing Corp.
Western Sintering Co.
Wicks Corp., The
The United States Graphite Co. Div.
Yale & Towne Mfg. Co., The
Powdered Metal Products Div.

Other Types

Chrysler Corp.
Amplex Div.
(stainless steel)
Deva-Metal Corp.
(nickel)
Engineered Plastics, Inc.
American Sinterings Div.
(stainless steel)
International Powder Metallurgy Co., Inc.
(aluminum)
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
(aluminum)
Kwikset Powdered Metal Products
(stainless steel, nickel)

CEMENTED CARBIDES

All Types

Adamas Carbide Corp.
Eaton Mfg. Co.
Powdered Metals Div.
Firth Sterling, Inc.
General Electric Co.
Metallurgical Products Dept.
Kennametal, Inc.
Mallory-Schwarzkopf Metals, Inc.
National Diamond Laboratory
Shieldalloy Corp.
Div. of Metallurg, Inc.
Sintercast Corp.
Tungsten Alloy Mfg. Co., Inc.
Welded Carbide Tool Co., Inc.
Wesson Metal Corp.

A new and better iron powder—Grade B-261—is finding new friends for *Plastic Metals*. Fabricators are discovering that compacts produced from B-261 offer improved tensile, hardness and elongation properties which have not been obtainable even with more costly copper-iron mixes.

PLAST-IRON Grade B-261 is just one of a large family of *pampered powders* produced by *Plastic Metals*, America's oldest commercial producer of iron powders. They're *pampered* by premixing, blending and balancing under rigid manufacturing controls in the most modern processing and packaging equipment available.

We will be glad to pamper a premix to your specifications, in lots as large as 24,000 pounds or more of a single mix.

ELECTROLYTIC AND REDUCED IRON POWDERS
Also nickel, steel and alloy powders—
for
—fabrication of fine machine parts,
cutting and scarfing of alloy steels,
manufacture of welding rods.

Tell us about your fabricating problems. We may have a premix precisely compounded to solve them. Write:

General Sales Office
342 Madison Avenue, New York 17, New York

District Offices
Chicago—Johnstown, Pa.—Los Angeles

PLASTIC METALS
Division of
National-U.S. Radiator Corporation

See us at Booths 17-19, MPA Annual Meeting, Drake Hotel, Chicago—April 29-May 1.

For more information circle No. 108 on the Reader Service Card

CONTACT MATERIALS

Pure Metals
(Platinum, Silver, Etc.)

Chrysler Corp.
Amplex Div.
Handy & Harman
(silver base)
P. R. Mallory & Co., Inc.
Metroloy Co.
Powder Metals Research
St. Marys Carbon Co.
Sintered Metals, Inc.
Technametals, Inc.

Tungsten Copper
(Tungsten Silver, Etc.)

Fansteel Metallurgical Corp.
Handy & Harman
Kwikset Powdered Metal Products
P. R. Mallory & Co., Inc.
National Diamond Laboratory
Powder Metals Research
Stackpole Carbon Co.
Superior Carbon Products, Inc.
Technametals, Inc.

CORES

Ferrites

Aerovox Corp.
Crowley Div.
National Moldite Co.
Stackpole Carbon Co.
Yale & Towne Mfg. Co., The
Powdered Metal Products Div.

High Frequency

Aerovox Corp.
Crowley Div.
Arnold Engineering Co., The
Engineered Plastics, Inc.
American Sinterings Div.
Ferroxcube Corp. of America
Indar Corp.
Jet Components, Inc.
Kwikset Powdered Metal Products
Magnetic Core Corp.
Micrometals
National Moldite Co.
Pyroferric Co., Inc.
Quality Components, Inc.
Radio Cores, Inc.
Stackpole Carbon Co.

Low Frequency

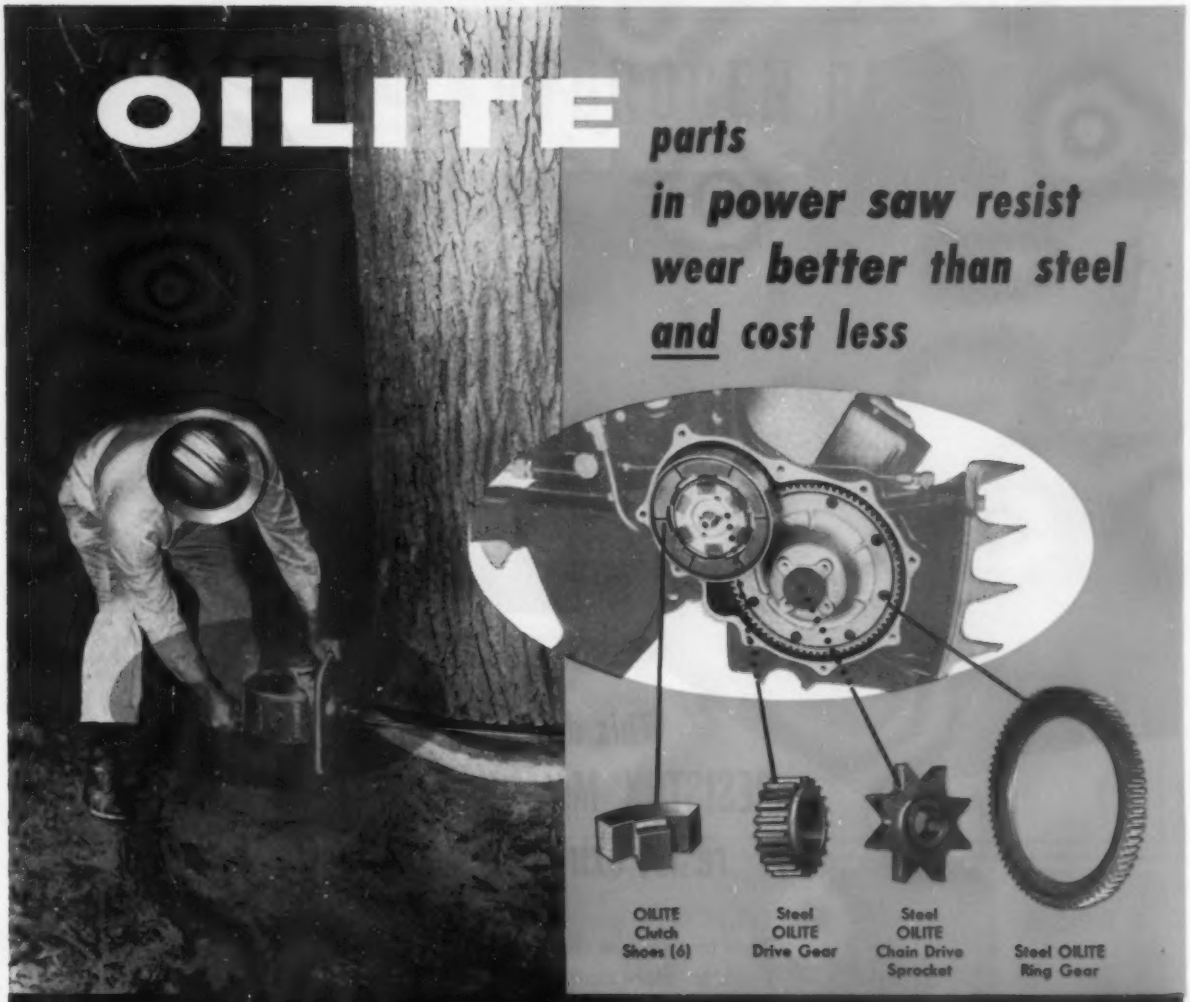
Aerovox Corp.
Crowley Div.
Arnold Engineering Co., The
Engineered Plastics, Inc.
American Sinterings Div.
Ferroxcube Corp. of America
Indar Corp.
Jet Components, Inc.
Kwikset Powdered Metal Products
Magnetic Core Corp.
Micrometals
National Moldite Co.
Pyroferric Co., Inc.
Quality Components, Inc.
Radio Cores, Inc.
Stackpole Carbon Co.

ELECTRICAL COMPONENTS

Collector Rings

Asco Sintering Corp.
Bunting Brass & Bronze Co., The
Chicago Powdered Metal Products Co.

OILITE parts in power saw resist wear better than steel and cost less



Another cost-saving application of **Amplex Powder Metallurgy**

With a modern power saw—easy does it. It's easier on the inside, too, because this manufacturer has equipped vital components with extra tough, greater wear resistant OILITE precision parts. The manufacturer's report indicates that OILITE powder metal sprockets and gears offer *greater wear resistance than alloy steels.*

Furthermore, in using OILITE precision parts the manufacturer of the power saw realizes *substantial cost savings over parts fabricated by any other process.*

What this manufacturer is accomplishing with OILITE precision parts, you can too. Or, perhaps, in your case OILITE self-lubricating bearings and bearing materials can help you lick the problem of providing lubrication in hard-to-get-at places. In permanent metal filters, too, OILITE provides a wide choice of shapes, sizes and porosities to meet product requirements.

Amplex—volume producer of Chrysler-engineered powder metal components—can meet your production schedules with on-time deliveries in any quantity.

Helping solve the problem of others is a daily occurrence at Amplex. This Chrysler-Amplex engineering service is available to you too.

Representatives and dealers located in principal cities in United States and Canada.

A CHRYSLER OILITE PRODUCT

Only Chrysler Makes **OILITE**

AMPLEX DIVISION

CHRYSLER CORPORATION • DETROIT 31, MICHIGAN

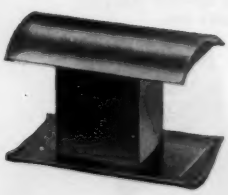
New 24 page OILITE bronze bearing stock list. Contains over 1000 sleeve, flange and thrust bearings—cored, bar and plate stock —engineering data. Write for booklet S-56. Address Dept. 4F

Bearings • Finished Machine Parts • Permanent Metal Filters • Friction Units

For more information circle No. 25 on the Reader Service Card

This do-it-yourself test proves

RESISTOX® Metal Powders are more stable, resist oxidation 5 to 10 times longer!



This test proves that the Resistox Process gives Glidden Metal Powders more stability through greater resistance to oxidation. You can store Glidden Resistox Metal Powders over long periods of time without fear of oxidation. And you can speed up production of metal parts, with less material-waste and die-wear, greatly improved finish, appearance, and performance characteristics.

In an open container, place a sample of Resistox copper or lead powder. In another, a like amount of an ordinary metal powder of the same type. Then wait . . . 3 days in hot humid weather, 2 weeks in cool dry weather. The striking difference in appearance that results (oxidation causes the ordinary metal powder to change color rapidly) will show comparative resistance to oxidation, prove superiority of Resistox Metal Powder.

Write for your free test-sample of Glidden Resistox Metal Powder (specify lead or copper) and complete information on these additional Glidden products: Cuprous Oxide, Cupric Oxide and Cubond (Copper Brazing Paste).

THE GLIDDEN COMPANY

CHEMICALS—PIGMENTS—METALS DIVISION

Baltimore, Md. • Collinsville, Ill. • Hammond, Ind. • Scranton, Pa.

QUALITY Glidden PRODUCTS — CHEMICALS PIGMENTS METALS

For more information circle No. 110 on the Reader Service Card

Chrysler Corp.
Amplex Div.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
Kwikset Powdered Metal Products
Metal Powder Products, Inc.
Picco Industries
Powdercraft Corp.
Sintered Metals, Inc.
Wicks Corp., The
The United States Graphite Co. Div.

Commutator Segments

American Sinteel Corp.
Asco Sintering Corp.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
Kwikset Powdered Metal Products
Sintered Metals, Inc.
Wicks Corp., The
The United States Graphite Co. Div.

Pole Pieces

Allied Products Corp.
Powdered Metal Parts Div.
American Powdered Metals, Inc.
American Sinteel Corp.
Arrow Sintered Products, Inc.
Asco Sintering Corp.
Bound Brook Oil-less Bearing Co.
Bunting Brass & Bronze Co., The
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
Globe Industries, Inc.
Supermet Div.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
Merriman Bros., Inc.
Metal Powder Products, Inc.
Midwest Sintered Products Corp.
Moraine Products Div.
General Motors Corp.
Pacific Sintered Metals Co.
Parker White Metal Co.

For more information circle No. 74 on the Reader Service Card

HYDROGEN REDUCED IRON POWDERS

Metallurgical Uses

Bearings & Structural Parts
Powder Cutting
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Friction Materials
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185 Amory Street Boston 30, Mass.

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P.O. Box 405, Berkeley, Calif.
33 University Ave., Rochester, New York
1811 Main St., East Hartford, Conn.
4324 W. Florissant Ave., St. Louis, Missouri
3092 Livingston Rd., Cleveland, Ohio

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For more information circle No. 77 on the Reader Service Card

POWDERED METAL PARTS
BY
Remet

We can reduce your costs and improve your product with the advantages of the powdered metal process. Our modern plant and technical facilities are at your disposal to meet your most exacting parts requirements. Your inquiry is solicited for study and quotation.

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TYPICAL PARTS:
Gears, pinions, cams, ratchets, bearings and bushings, machine and structural parts.

SPECIAL, high speed rotary presses available for high quantity, small part production

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Iron Powders
Steel Powders
Iron Alloy Powders
Flame Cutting Powders

WE ARE NOW PREPARED TO OFFER ALL TYPES OF NON-FERROUS POWDER (EXCEPT COPPER) AND NON-FERROUS ALLOY POWDERS.

Your Inquiries Welcomed

Our representative will be in attendance at the Metal Powder Show.

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CANADA

For more information circle No. 107 on the Reader Service Card

Picco Industries
Powdercraft Corp.
Reese Metal Products Corp.
Sintered Metals, Inc.
Symmco, Inc.
Wicks Corp., The
The United States Graphite Co. Div.
Yale & Towne Mfg. Co., The Powdered Metal Products Div.

Rotor Segments

American Sinteel Corp.
Asco Sintering Corp.
Chicago Powdered Metal Products Co.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
Globe Industries, Inc.
Supermet Div.
Kwikset Powdered Metal Products
Picco Industries
Powdercraft Corp.
Sintered Metals, Inc.
Wicks Corp., The
The United States Graphite Co. Div.

FRICTION MATERIALS

American Brake Shoe Co.
Chrysler Corp.
Amplex Div.
Ferro Powdered Metals
General Metals Powder Co., The
Kwikset Powdered Metal Products
Moraine Products Div.
General Motors Corp.
Powdercraft Corp.
Raybestos-Manhattan, Inc.
S. K. Wellman Co., The

MAGNETIC MATERIALS

Hard — Alnico Type

Arnold Engineering Co., The
Ferro Powdered Metals
Ferroxcube Corp. of America
General Electric Co.
Metallurgical Products Dept.
General Magnetic Corp.
Indiana Steel Products Co., The
Jet Components, Inc.
Permag Corp.

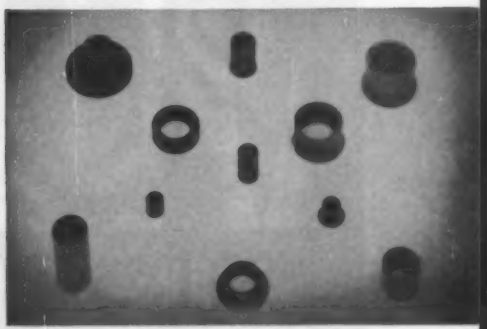
Hard — Other Types

Aerovox Corp.
Crowley Div.
Ferro Powdered Metals
Ferroxcube Corp. of America
Indar Corp.
Indiana Steel Products Co., The
Stackpole Carbon Co.

Soft

Aerovox Corp.
Crowley Div.
Chrysler Corp.
Amplex Div.
Ferroxcube Corp. of America
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.

Fabricated parts and gears formed on Baldwin Compacting Presses.



Typical straight and flanged powdered metal bushings made on Baldwin Compacting Presses.

Other parts being made at United States Graphite on Baldwin presses. The double hub and counterbored parts are test pieces. Others are production items.

New, low-cost compacting presses for powdered metals and ceramics

Baldwin-Lima-Hamilton Corporation announces that its 100 years' experience and know-how in building hydraulic presses has been incorporated in a new, low-cost compacting press—the 30W—specifically designed to serve the powdered metal and ceramics industry.

Its 1-piece frame and floating die deliver the same uniform pressure, the same rigid 4-point guiding, as our regular heavy duty 4-column hydraulic presses. The 30W is designed for versatility—extra motions may be added as requirements become more complex without the need for additional machining.

Rated pressure of the Baldwin Model 30W is 30 tons, with a 20-ton ejection capacity. Stroke is adjustable through its entire fill range of 0 to 4½ in. For complete details, including specifications, write to the Hamilton Division, B-L-H Corporation, Hamilton, Ohio.

Hamilton Division Hamilton, Ohio

BALDWIN · LIMA · HAMILTON

Diesel engines • Mechanical presses • Can making machinery • Machine tools

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MORE

DESIGN FREEDOM
PRODUCTION CAPACITY
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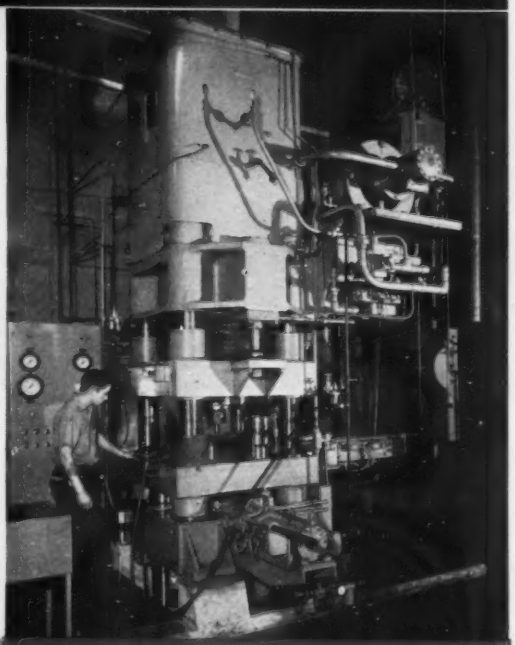
...YOURS WITH BURGESS-NORTON QUALI-SINT...
LOW-COST, HIGH-STRENGTH SINTERED STEEL PARTS

Latest addition to the constantly expanding powdered metal facilities at Burgess-Norton is this 500-ton compacting press, largest of its type ever built. Exceptional facilities are only part of the Quali-SINT story. Engineering skill, quality control and wide experience in solving some of the toughest production problems in the industry are among the other reasons so many manufacturers are turning to B-N® for cost-saving sintered steel parts.



If you have a parts problem, Quali-SINT may be your answer. Send the coupon for more information.

☐ Please send me the informative Quali-SINT folder ☐ Have your representative call

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Address_____

City_____ Zone_____ State_____

Name_____ Title_____

Quali-SINT®

another development in precision parts production by

BURGESS-NORTON MFG. CO.

Geneva 2, Illinois

For more information circle No. 16 on the Reader Service Card

Keystone Carbon Co.
Metal Powder Products, Inc.
Pacific Sintered Metals Co.
Stackpole Carbon Co.

Iron Nickel

Asco Sintering Corp.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Ferro Powdered Metals
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
Moraine Products Div.
General Motors Corp.
Powdercraft Corp.
Sintered Metals, Inc.

Iron Silicon

Ferro Powdered Metals
Kwikset Powdered Metal Products
Sintered Metals, Inc.

Other Types

Bound Brook Oil-less Bearing Co.
(pure iron)
Bunting Brass & Bronze Co., The
(pure iron)
Chrysler Corp.
Amplex Div.
(pure iron)
Keystone Carbon Co.
(pure iron)

STRUCTURAL PARTS

Brass

American Sinteel Corp.
Asco Sintering Corp.
Bound Brook Oil-less Bearing Co.
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
General Sintering Corp.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
Jet Components, Inc.
Johnson Bronze Co.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
Merriman Bros., Inc.
Midwest Sintered Products Corp.
Mueller Brass Co.
National Molded Products, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Presmet Corp., The
Pure Carbon Co., Inc.
Reese Metal Products Corp.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Symmco, Inc.
Wakefield Bearing Corp.
Western Sintering Co.
Wicks Corp., The
The United States Graphite Co. Div.
Yale & Towne Mfg. Co., The
Powdered Metal Products Div.

Copper Base

American Powdered Metals, Inc.
American Sinteel Corp.
Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Brockway Pressed Metals, Inc.
Bunting Brass & Bronze Co., The
Carbon City Products Co., Inc.
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
Ford Motor Co.
Accessory Div.
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
General Sintering Corp.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
Jet Components, Inc.
Johnson Bronze Co.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
P. R. Mallory & Co., Inc.
Merriman Bros., Inc.
Metal Powder Products, Inc.
Midwest Sintered Products Corp.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
National Molded Products, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Picco Industries
Powdercraft Corp.
Precision Metal Products Co.
Presmet Corp., The
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Symmco, Inc.
Technametals, Inc.
Wakefield Bearing Corp.
Western Sintering Co.
Wicks Corp., The
The United States Graphite Co. Div.
Yale & Towne Mfg. Co., The
Powdered Metal Products Div.

Filters

Arrow Sintered Products, Inc.
Asco Sintering Corp.
Kwikset Powdered Metal Products
Micro Metallic Corp.
Powdercraft Corp.
Precision Metal Products Co.
St. Marys Carbon Co.

Iron Base, Controlled Porosity

Allied Products Corp.
Powdered Metal Parts Div.
American Powdered Metals, Inc.
American Sinteel Corp.
Arrow Sintered Products Co.
Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Brockway Pressed Metals, Inc.
Bunting Brass & Bronze Co., The
Burgess-Norton Mfg. Co.
Carbon City Products Co., Inc.
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
Ford Motor Co.
Accessory Div.
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
General Sintering Corp.
Globe Industries, Inc.
Supermet Div.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
Jet Components, Inc.
Johnson Bronze Co.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
P. R. Mallory & Co., Inc.
Merriman Bros., Inc.
Metal Powder Products, Inc.
Midwest Sintered Products Corp.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
National Molded Products, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Picco Industries
Powdercraft Corp.
Precision Metal Products Co.
Presmet Corp., The
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Symmco, Inc.
Technametals, Inc.
Wakefield Bearing Corp.
Western Sintering Co.
Yale & Towne Mfg. Co., The
Powdered Metal Products Div.

Iron Base, High Density, Copper Free

Allied Products Corp.
Powdered Metal Parts Div.
American Powdered Metals, Inc.
American Sinteel Corp.
Arrow Sintered Products Co.
Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Bunting Brass & Bronze Co., The
Carbon City Products Co., Inc.
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Compacted Metals Corp.
Dixon Sintaloy, Inc.

Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
General Sintering Corp.
Globe Industries, Inc.
Supermet Div.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
Jet Components, Inc.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
Merriman Bros., Inc.
Metal Powder Products, Inc.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
Pacific Sintered Metals Co.
Parker White Metal Co.
Picco Industries
Powdercraft Corp.
Presmet Corp., The
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Symmco, Inc.
Technametals, Inc.
Wakefield Bearing Corp.
Western Sintering Co.
Wicks Corp., The
The United States Graphite Co. Div.

Iron Base, Infiltrated

Allied Products Corp.
Powdered Metal Parts Div.
American Powdered Metals, Inc.
American Sinteel Corp.
Arrow Sintered Products Co.
Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Bunting Brass & Bronze Co., The
Carbon City Products Co., Inc.
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
Ford Motor Co.
Accessory Div.
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
General Sintering Corp.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
Jet Components, Inc.
Johnson Bronze Co.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
P. R. Mallory & Co., Inc.
Merriman Bros., Inc.
Metal Powder Products, Inc.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
National Molded Products, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Picco Industries
Powder Metal Products, Inc.
Powdercraft Corp.
Presmet Corp., The
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Symmco, Inc.
Technametals, Inc.
Wakefield Bearing Corp.
Western Sintering Co.
Wicks Corp., The
The United States Graphite Co. Div.
Yale & Towne Mfg. Co., The
Powdered Metal Products Div.

Nickel Silver

American Powdered Metals, Inc.
American Sinteel Corp.
Arrow Sintered Products Co.
Asco Sintering Corp.
Bound Brook Oil-less Bearing Co.
Bunting Brass & Bronze Co., The
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals
General Powdered Metal Products, Inc.
Sub. of Holly Corp.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy Co., Inc.
Rocky Mountain Metals Div.
Jet Components, Inc.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Merriman Bros., Inc.
Metal Powder Products, Inc.
Midwest Sintered Products Corp.
National Molded Products, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Powdercraft Corp.
Presmet Corp., The
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Wakefield Bearing Corp.
Western Sintering Co.
Wicks Corp., The
The United States Graphite Co. Div.
Yale & Towne Mfg. Co., The
Powdered Metal Products Div.

Stainless Steel

American Sinteel Corp.
Eaton Mfg. Co.
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Wakefield Bearing Corp.

EQUIPMENT SUPPLIERS

DIES AND TOOLS

Adamas Carbide Corp.
Allegheny Ludlum Steel Corp.
Carmet Div.
Champion Tool & Die Co.
Cleveland Tool & Die Co.
Arthur Colton Co.
Curtis Carbide Die Co.
Diecraft Tool Co.
Eaton Mfg. Co.
Powdered Metals Div.
Elizabeth Carbide Die Co., Inc.
Firth Sterling, Inc.
General Electric Co.
Metallurgical Products Dept.
Kennametal, Inc.
Micro-Carbide Tool & Die Co., Inc.
Monarch Tool & Gauge Co.
National Carbide Die Co.
National Diamond Laboratory
Sintercast Corp.
John E. Skach Tool Co.
F. J. Stokes Corp.
Tungsten Alloy Mfg. Co., Inc.
Vanadium-Alloys Steel Co.
Vascaloy-Ramet Corp.
Welded Carbide Tool Co., Inc.

FURNACES
Electric

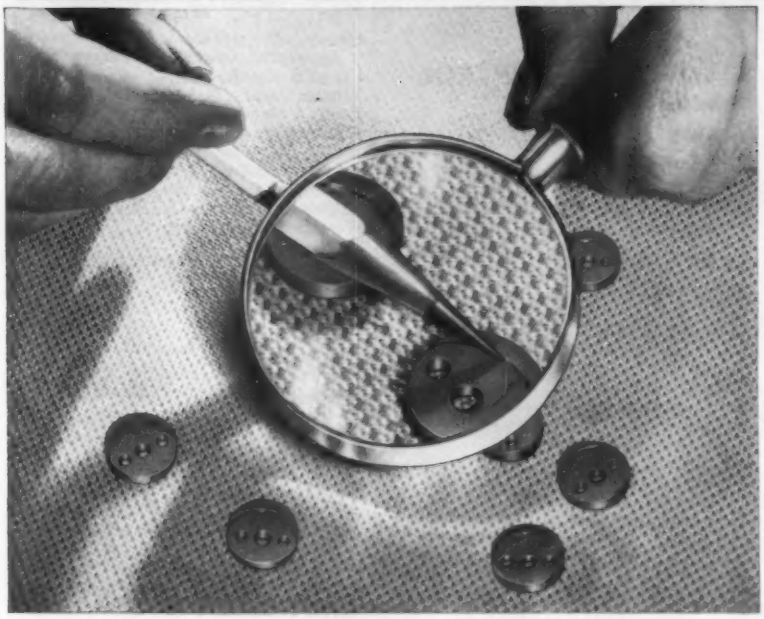
Abbot Corp.
Ajax Electrothermic Corp.
Continental Industrial Engineers, Inc.
Drever Co.
Electric Furnace Co., The
Ferguson Equipment Corp.
Gas Machinery Co., The
General Electric Co.
Apparatus Sales Div.
Harper Electric Furnace Corp.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
Holcroft & Co.
Leeds & Northrup Co.
Lindberg Engineering Co.
Lithium Co., The
Mallory-Schwarzkopf Metals, Inc.
Pereny Equipment Co.
Posey Iron Works, Inc.
Industrial Heating Div.
Sargeant & Wilbur, Inc.
Sentry Co., The
F. J. Stokes Corp.
(vacuum)
Sunbeam Corp.
Industrial Furnace Div.
Surface Combustion Corp.
Westinghouse Electric Corp.

FURNACES
Fuel Fired

Abbot Corp.
Continental Industrial Engineers, Inc.
Drever Co.
(vacuum)
Eclipse Fuel Engineering Co.
Electric Furnace Co., The
Falcon Equipment Co.
Ferguson Equipment Corp.
Gas Machinery Co., The
Holcroft & Co.
Leeds & Northrup Co.
Lindberg Engineering Co.
Lithium Co., The
Posey Iron Works, Inc.
Industrial Heating Div.
Sargeant & Wilbur, Inc.

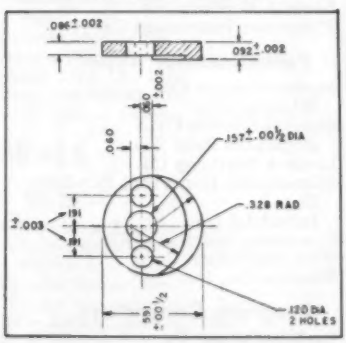
POWDER METALLURGY NEWS

An informative service by HOEGANAES SPONGE IRON CORPORATION, manufacturer of *HOEGANAES SPONGE IRON POWDERS*



HOEGANAES SELECTED ON BASIS OF UNIFORMITY

Arrow Sintered Products Co., Chicago, relies on *uniformity* of the iron powders they specify—that's why Hoeganaes was specified over three competitive brands. Larry Korenchan, General Manager, knows that *uniformity*, from month to month, from year to year, pays off.



Arrow Sintered Products Co. knows that this Eccentric Cam—manufactured for communications equipment—will meet specifications a month from now, or a year from now. They can rely on *future identical characteristics* of dimensional control, green and sintered strengths, and exceptional wearability.

The mix was 97% Hoeganaes MH-100, 3% Copper and 1% Zinc Sterate. The drawing to the left indicates the kind of performance demanded of Hoeganaes MH-100.

Hoeganaes MH-100 has good compressibility and in many cases, is famous for iron-carbon mixtures. Outstanding infiltration properties—fast and controllable. For time-tested qualities, MH-100 is the field-tested selection for iron-carbon mixes.

Riverton Production Now Includes the Famous Blue Line

Call it the Blue Line; or refer to it as Mr. Uniformity. In both cases, you would be referring to Hoeganaes Ancor MH-100.

This famous - for - performance sponge iron powder *is now manufactured at Riverton, N. J.*

Not only now available from a nearby source but plans are already underway to add new manufacturing facilities to increase tonnage . . . making your source nearby and adequate.

Hoeganaes Offers Stainless Powders and Powdered Alloys

Produced by a newly developed atomizing process, Hoeganaes now offers stainless grades AISI type No. 302B and No. 316. In addition, a variety of alloys in powder form are also available.

Two mesh sizes are standard: −40 +100 mesh for filters and −100 mesh for structural parts. Controlled particle shape from spherical to irregular. Even powder quality. Low oxygen content. Completely prealloyed powders . . . and high physicals.

Fabricators Eliminate "Trial and Error" of Powder Blending

Some fabricators of powder metal parts have forever eliminated the headaches and high waste costs associated with powder mixing.

Their solution was simplicity itself. *Hoeganaes blends their mixes for them.* That's right, a new Hoeganaes service has just been announced of "Custom Blending," ready for the press.

Just announced—but proven in operation since September 1956. Since that time, many fabricators have supplemented their mix departments. And regardless of the powder mix combination, through free exchange of operating data, they rely exclusively on Hoeganaes.

Consider the savings to the fabricator. Rejects are eliminated . . . overhead costs reduced . . . and mix-production worries are a thing of the past.

Interested? Your Hoeganaes Sales-Engineer has *all* the facts.

Hoeganaes Sponge Iron Corporation,
Riverton, New Jersey

Please send me your free literature on Powder Metallurgy.

Name .....

Company .....

City ..... Zone ... State .....

HOEGANAES
SPONGE IRON
POWDERS

Superior grade metal parts from superior grade iron powder.

HOEGANAES
SPONGE IRON CORP.
General Offices and Plant
RIVERTON, NEW JERSEY

For more information circle No. 45 on the Reader Service Card

Sunbeam Corp.
Industrial Furnace Div.
Surface Combustion Corp.
Westinghouse Electric Corp.

GAS GENERATORS FOR CONTROLLED ATMOSPHERES

Anhydrous Ammonia

Armour & Co.
Ammonia Div.
Henry Bower Chemical Mfg. Co.
Hamler Industries, Inc.

Completely Combusted (Ex-Thermic) Gas

Continental Industrial Engineers, Inc.
Drever Co.
Electric Furnace Co., The
Ferguson Equipment Corp.
Gas Machinery Co., The
General Electric Co.
Apparatus Sales Div.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
Holcroft & Co.
C. M. Kemp Mfg. Co., The
Lindberg Engineering Co.
Lithium Co., The
Sargeant & Wilbur, Inc.
Sunbeam Corp.
Industrial Furnace Div.
Surface Combustion Corp.
Westinghouse Electric Corp.

Partially Combusted (Endo-Thermic) Gas

Continental Industrial Engineers, Inc.
Eclipse Fuel Engineering Co.
Electric Furnace Co., The
Ferguson Equipment Corp.
Gas Machinery Co., The
General Electric Co.
Apparatus Sales Div.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
Holcroft & Co.
Lindberg Engineering Co.
Lithium Co., The
Sargeant & Wilbur, Inc.
Sunbeam Corp.
Industrial Furnace Div.
Surface Combustion Corp.
Westinghouse Electric Corp.

Dissociated Ammonia

Continental Industrial Engineers, Inc.
Drever Co.
Electric Furnace Co., The
General Electric Co.
Apparatus Sales Div.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
Lindberg Engineering Co.
Lithium Co., The
Sargeant & Wilbur, Inc.
Surface Combustion Corp.
Westinghouse Electric Corp.

Liquid Hydrocarbon Decomposition

Continental Industrial Engineers, Inc.
General Electric Co.
Apparatus Sales Div.
Hevi-Duty Electric Co.
Lindberg Engineering Co.
Lithium Co., The
Surface Combustion Corp.

IMPREGNATION EQUIPMENT

For Sealing Porous Parts

Curd Enterprizes, Inc.
Multiplastics Div.
(vacuum and pressure)
Ideal Industries, Inc.
Imprex Div.
F. J. Stokes Corp.
(vacuum and pressure)

LABORATORY CONTROL & INSPECTION EQUIPMENT

Federal Classifier Systems, Inc.
Haller, Inc.
Loomis Engineering & Mfg. Co.
(laboratory)

LUBRICANTS

(Die & Powder)

Acheson Colloids Co.
American Cyanamid Co.
Capital City Products Co., The
Foote Mineral Co.
Leffingwell Chemical Co.
Nopco Chemical Co.
M. W. Parsons-Plymouth, Inc.
Sun Chemical Corp.
Warwick Chemical Co. Div.
Whittaker, Clark & Daniels, Inc.
Witco Chemical Co.

MIXING & BLENDING EQUIPMENT

R. N. Bailey & Co., Inc.
Baker Perkins, Inc.
Capitol Products Corp.
Read Standard Div.
Arthur Colton Co.
J. H. Day Co., Inc., The
Mercer-Robinson Co., Inc.
National Engineering Co.
Simpson Mix Muller Div.

PRESSES

Hydraulic

American Brake Shoe Co.
Denison Engineering Div.
Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp.
Lowey-Hydropress Div.
E. W. Bliss Co.
Clifton Hydraulic Press Co.
Haller, Inc.
Hannifin Corp.
Kux Machine Co.
Lake Erie Engineering Corp.
Loomis Engineering & Mfg. Co.
(laboratory)
M & N Modern Hydraulic Press Co., Inc.
Oliver Corp., The
A. B. Farquhar Div.
Standard Machinery Co.
F. J. Stokes Corp.

Mechanical

Arnhold Ceramics, Inc.
Baldwin-Lima-Hamilton Corp.
E. W. Bliss Co.
Arthur Colton Co.
Haller, Inc.
Johnson Machine & Press Corp.
Div. of Bontrager Corp.
Kux Machine Co.
Mansol Ceramic Co.
Minster Machine Co., The
Standard Machinery Co.
F. J. Stokes Corp.

PYROMETERS & PYROMETRIC EQUIPMENT

Compensating Lead Wire

Barber-Colman Co.
Wheelco Div.
General Electric Co.
Apparatus Sales Div.
Claud S. Gordon Co.
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
Pyrometer Instrument Co.
Arklay S. Richards Co., Inc.
West Instrument Corp.

Fuel Failure Protective Devices For Fuel Fired Furnaces

Barber-Colman Co.
Wheelco Div.
Illinois Testing Laboratories, Inc.
Minneapolis-Honeywell Regulator Co.
Industrial Div.

Millivoltmeter Type

Barber-Colman Co.
Wheelco Div.
General Electric Co.
Apparatus Sales Div.
Claud S. Gordon Co.
Illinois Testing Laboratories, Inc.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
Pyrometer Instrument Co., Inc.
Simpson Electric Co.
West Instrument Corp.
Winslow Co., Inc., The

Optical Pyrometers

Claud S. Gordon Co.
Leeds & Northrup Co.
Pyrometer Instrument Co.

Potentiometer Type

Barber-Colman Co.
Wheelco Div.
General Electric Co.
Apparatus Sales Div.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
Pyrometer Instrument Co.
West Instrument Corp.
Winslow Co., Inc., The

Program Controllers

Barber-Colman Co.
Wheelco Div.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
West Instrument Corp.

Thermocouples

Barber-Colman Co.
Wheelco Div.
General Electric Co.
Apparatus Sales Div.
Claud S. Gordon Co.
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Industrial Div.

Pyrometer Instrument Co.
Arklay S. Richards Co., Inc.
Service Associated, Inc.
Simpson Electric Co.
West Instrument Corp.
Winslow Co., Inc., The

Thermocouple Failure Protective Devices

Barber-Colman Co.
Wheelco Div.
Claud S. Gordon Co.
Illinois Testing Laboratories, Inc.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
West Instrument Corp.

Thermocouple Protective Tubes

Barber-Colman Co.
Wheelco Div.
Claud S. Gordon Co.
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Industrial Div.
Morganite, Inc.
Arklay S. Richards Co., Inc.
Service Associated, Inc.
West Instrument Corp.

SCREENING EQUIPMENT

R. N. Bailey & Co., Inc.
J. H. Day Co., Inc., The
Exolon Co., The
B. F. Gump Co.
Mercer-Robinson Co., Inc.
W. S. Tyler Co., The

POWDER SUPPLIERS

ALUMINUM

Aluminum Company of America
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
Metals Disintegrating Co., Inc.
Reade Mfg. Co., Inc.
Reynolds Metals Co.
U. S. Bronze Powder Works, Inc.

BRASS

80-20

Alloy Metal Powders, Inc.
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
Malone Metal Powders, Inc.
New Jersey Zinc Co., The
U. S. Bronze Powder Works, Inc.

70-30

Alloy Metal Powders, Inc.
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
Malone Metal Powders, Inc.
New Jersey Zinc Co., The
U. S. Bronze Powder Works, Inc.

60-40

Alloy Metal Powders, Inc.
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
Malone Metal Powders, Inc.
New Jersey Zinc Co., The
U. S. Bronze Powder Works, Inc.

Perhaps

SUPERIOR Powdered Metal Parts

CAN CUT Your COSTS IN HALF, TOO!

CUT COSTS, NOT PARTS

Superior Powder Metallurgy often makes possible tremendous savings. Parts virtually impossible with other materials are easy with this method. Note the other advantages listed above and then...tell us what your job or problem is, preferably via blue print or drawing. Perhaps we can cut *your* costs in half, too.

SUPERIOR CARBON PRODUCTS, INC.
9115 GEORGE AVENUE • CLEVELAND 5, OHIO

SCP
SUPERIOR CARBON BRUSHES
"Since 1919"

For more information circle No. 105 on the Reader Service Card

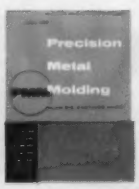
Where can you buy a steel casting like this?

If you want an up-to-date list of investment casting producers watch for PMM's June issue. It will have a complete buyers' guide cross-referenced alphabetically, geographically and by metals cast. It will also tell where to buy special alloys and equipment for investment casting. Coming in June . . .

The 2nd Annual

INVESTMENT CASTING DIRECTORY

If you sell investment castings or the alloys or equipment for making them, your ad in the June issue of PRECISION METAL MOLDING will be read and saved for a whole year.



COPPER

Atomized

Belmont Smelting & Refining Works, Inc.
Greenback Industries, Inc.
Charles Hardy, Inc.
Malone Metal Powders, Inc.
New Jersey Zinc Co., The
U. S. Bronze Powder Works, Inc.

Electrolytic

American Metal Co. Ltd., The
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.

Reduced

Glidden Co., The Chemicals-Pigments-Metals Div.
Metals Disitegrating Co., Inc.
Whitaker Metals Corp.

Sponge

Greenback Industries, Inc.

IRON

Atomized

Belmont Smelting & Refining Works, Inc.
Ferrum Limited
Charles Hardy, Inc.
Metal Powders Limited

Carbonyl

Belmont Smelting & Refining Works, Inc.
General Aniline & Film Corp. Antara Chemicals Div.
Charles Hardy, Inc.
Magnetic Powders, Inc.

Decarburized Cast Iron

Easton Metal Powder Co., Inc.
Charles Hardy, Inc.

Electrolytic

Belmont Smelting & Refining Works, Inc.
Easton Metal Powder Co., Inc.
Charles Hardy, Inc.
A. Johnson & Co., Inc.
National-U.S. Radiator Corp. Plastic Metals Div.
Shieldalloy Corp. Div. of Metallurg, Inc.

Hydrogen Reduced

Alan Wood Steel Co.
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
Magnetic Powders, Inc.
National-U.S. Radiator Corp. Plastic Metals Div.
Pyron Corp.
Republic Steel Corp. Metal Powder Div.
C. K. Williams & Co.

Sponge

Alan Wood Steel Co.
Belmont Smelting & Refining Works, Inc.
Easton Metal Powder Co., Inc.
Ferrum Limited
Hoeganaes Sponge Iron Corp.
Magnetic Powders, Inc.
Metal Powders Limited
Micronized Metals, Inc.
National-U.S. Radiator Corp. Plastic Metals Div.

LEAD

Belmont Smelting & Refining Works, Inc.
Glidden Co., The Chemicals-Pigments-Metals Div.
Charles Hardy, Inc.
Metals Disintegrating Co., Inc.

NICKEL

Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
Metals Disintegrating Co., Inc.
Micronized Metals, Inc.
National-U.S. Radiator Corp. Plastic Metals Div.
Powder Metals Research
Pyron Corp.
Vanadium-Alloys Steel Co.

NICKEL SILVER

Alloy Metal Powders, Inc.
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
New Jersey Zinc Co., The
Reade Mfg. Co., Inc.

STEEL

High Alloy

Alloy Metal Powders, Inc.
Charles Hardy, Inc.
Hoeganaes Sponge Iron Corp.
Uniworld Research Corp. of America
Vanadium-Alloys Steel Co.

Low Alloy

Alloy Metal Powders, Inc.
Charles Hardy, Inc.
Hoeganaes Sponge Iron Corp.
Metal Powders Limited
Pyron Corp.
Vanadium-Alloys Steel Co.

Plain Carbon

Alloy Metal Powders, Inc.
Charles Hardy, Inc.
Metal Powders Limited
Vanadium-Alloys Steel Co.

Stainless

Alloy Metal Powders, Inc.
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
Hoeganaes Sponge Iron Corp.
Micronized Metals, Inc.
Uniworld Research Corp. of America
Vanadium-Alloys Steel Co.

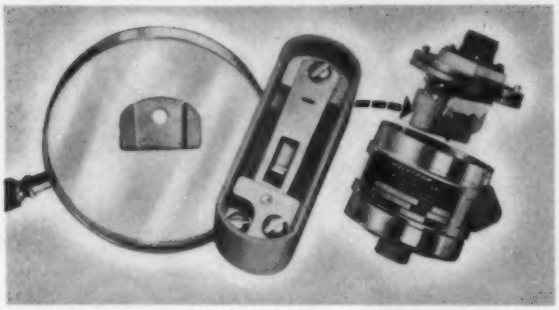
TIN

American Metal Co. Ltd., The
Belmont Smelting & Refining Works, Inc.
Glidden Co., The Chemicals-Pigments-Metals Div.
Greenback Industries, Inc.
Charles Hardy, Inc.
Metals Disintegrating Co., Inc.
Reade Mfg. Co., Inc.

MEETING DESIGN NEEDS

FOR HIGH STANDARDS AND LOW UNIT COSTS

MELETRON USES BRASS POWDER

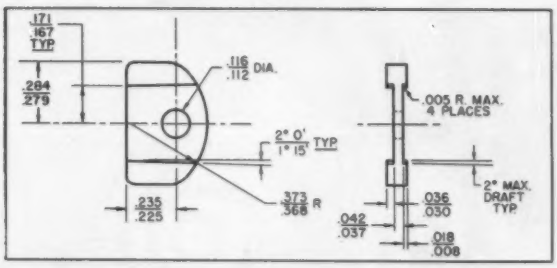


Design requirements for these automatic electric controls are very rigid because of exposure to extreme temperature, humidity, dust, and vibration in all types of aircraft and industrial equipment. The heart of this Pressure Actuated Switch is the contact element that can be set to a specified change in pressure and then relay the change to an outside electric circuit.

BRASS sinterings were chosen by Meletron, pioneers in the manufacture of Pressure Actuated Switches, for this switch contact because of high electrical conductivity and corrosion resistance. Their fabricator* met the high performance standards of the industry at a low unit cost and, equally important, at a low tooling cost.

When evaluating your design needs, first investigate powder metallurgy. Find out what BRASS AND OTHER NONFERROUS POWDER PARTS can do for your products.

*Pacific Sintered Metals Company, Los Angeles.



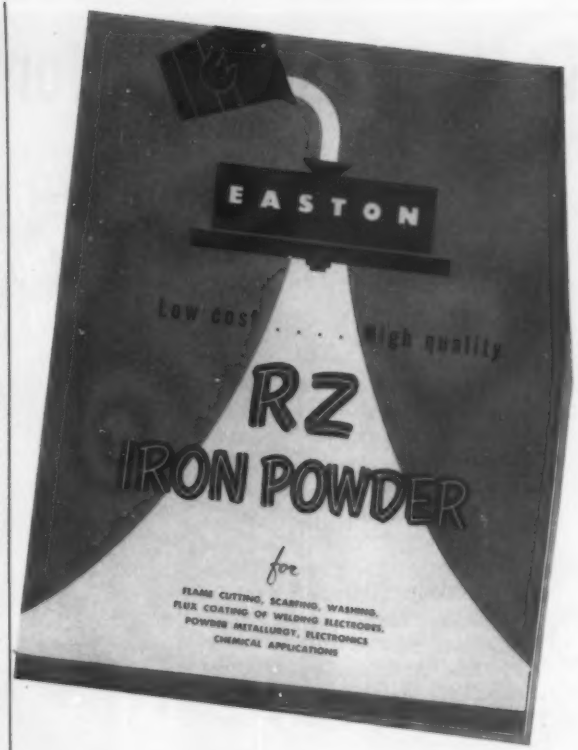
How Can BRASS AND NICKEL SILVER POWDER PARTS Meet Your Design Needs?

For detailed information on the design, properties, production and application of brass and other nonferrous powder parts you should have a copy of our manual. It will give you 20 case histories of brass and nickel silver powder structural parts to assist in evaluating this means of production in terms of your particular needs.

SEND FOR YOUR COPY

THE NEW JERSEY ZINC COMPANY
160 Front Street New York 38, N.Y.

For more information circle No. 67 on the Reader Service Card



HERE'S HELP WITH YOUR METAL POWDER PROBLEMS

MORE AND MORE powdered metal parts fabricators are turning to Easton. In blends, mixes or alone, the unique particle shape of RZ 365 molding powder means easier compressibility and greater tensile strength.

FOR YOU Easton has enlarged the powder production facilities to give high quality and maximum physical properties in every bag of every shipment.

Write for specific information without obligation.

EASTON RZ

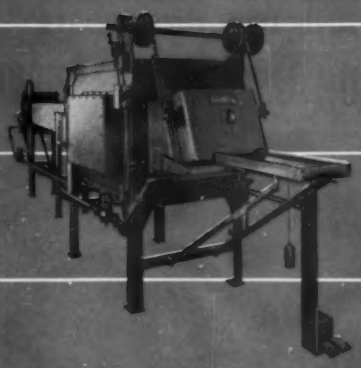
EASTON METAL POWDER CO., INC.

233 Broadway, New York 7, N.Y.

For more information circle No. 37 on the Reader Service Card

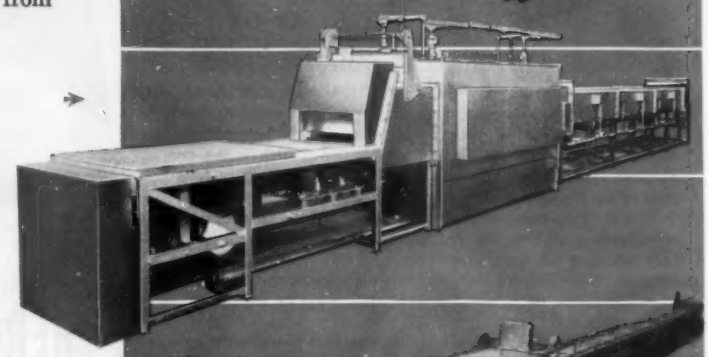
Look to Lindberg for Sintering Furnaces

For sintering furnaces, just as in all types of industrial heating equipment, you can depend on Lindberg's ability to supply exactly the right equipment for your needs. Here are some typical Lindberg sintering furnaces:



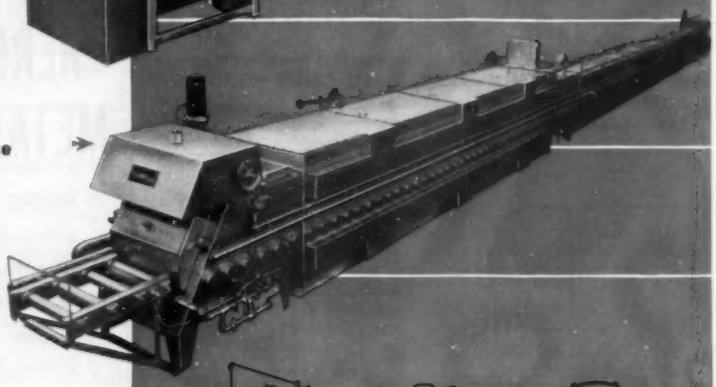
This Hand Pusher Batch Type Furnace

is used for small production lots and experimental sintering. It is an all-purpose unit for operation from 1300°F to 2500°F. Made in various sizes for sintering from 25 to 300 pounds per hour.



This Mesh Belt Continuous Type Furnace

is a popular sintering furnace for small light parts in copper, bronze, brass or steel with a temperature range from 1300°F. to 2100°F. It can be used for low temperature silver brazing, bright annealing, as well as sintering of powder metals. Production ranges up to 500 pounds per hour.



This Roller Hearth Continuous Type Furnace

is especially designed to handle heavier loads up to 2200 pounds per hour. It has an effective temperature range from 1300°F. to 2100°F. It can be used for bright annealing, low temperature silver brazing as well as sintering of powder metals.

Atmosphere Generators

To obtain the best work from any sintering furnaces, the proper atmosphere is required. The atmosphere generators described here provide the proper atmospheres recommended for use with Lindberg Sintering Furnaces.

1. The HYEX Generator produces atmosphere composed of approximately 4% carbon dioxide—19% hydrogen—12% carbon monoxide and 66% nitrogen.

2. The HYEN Generator produces a neutral atmosphere composed of approximately 21% carbon monoxide—40% hydrogen—38% nitrogen and 1% methane.

3. The HYAM Generator produces atmosphere composed of approximately 75% hydrogen and 25% nitrogen.

If you have a sintering or brazing problem why not talk it over with Lindberg. Just get in touch with your nearest Lindberg Field Representative or write us direct.

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Foote Mineral Co. (manganese, chromium, zirconium)
Charles Hardy, Inc. (most other metal powders)
Metal Hydrides, Inc. (chromium, titanium, zirconium master alloys)
Metal Powders Ltd. (8% copper, 3% nickel)
National-U.S. Radiator Corp. Plastic Metals Div. (iron-aluminum, iron-titanium)
New Jersey Zinc Co., The (bronzes)
Powder Metals Research (cobalt, tungsten carbide, tungsten alloy)
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Detroit, Mich.

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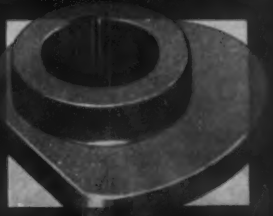

TYPE "G"
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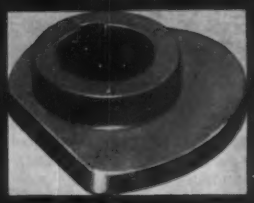

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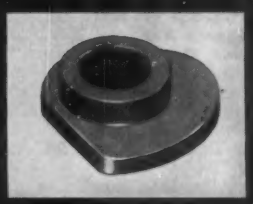

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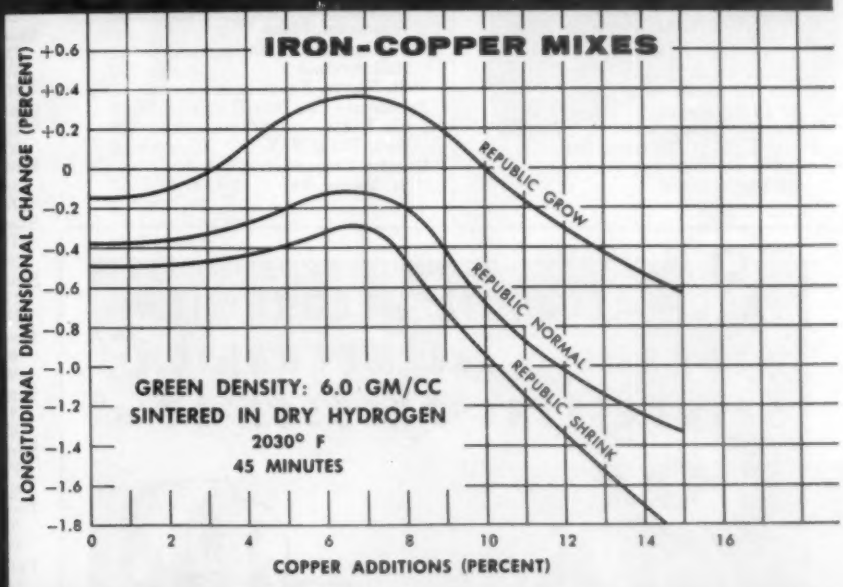

The above chart shows the distinct dimensional change-characteristic that occurs when any one of Republic's three new Iron Powders—Type "G" for growth, Type "N" for normal, Type "S" for shrinkage—is blended with varying amounts of copper.

This change-characteristic is called *Controlled Dimensional Factor*—an exclusive Republic development.

The dimensional changes that occur, upon sintering, are shown for tensile bars pressed to a green density of 6.00 gm/cc. The bars were sintered in a dry hydrogen atmosphere at 2030°F. for 45 minutes. All values in this chart represent the average of numerous tests conducted by Republic's Metal Powder Division in the development of these new types of Iron Powder. In all cases, one percent zinc stearate was used as lubricant.

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Parker White Metal Co.
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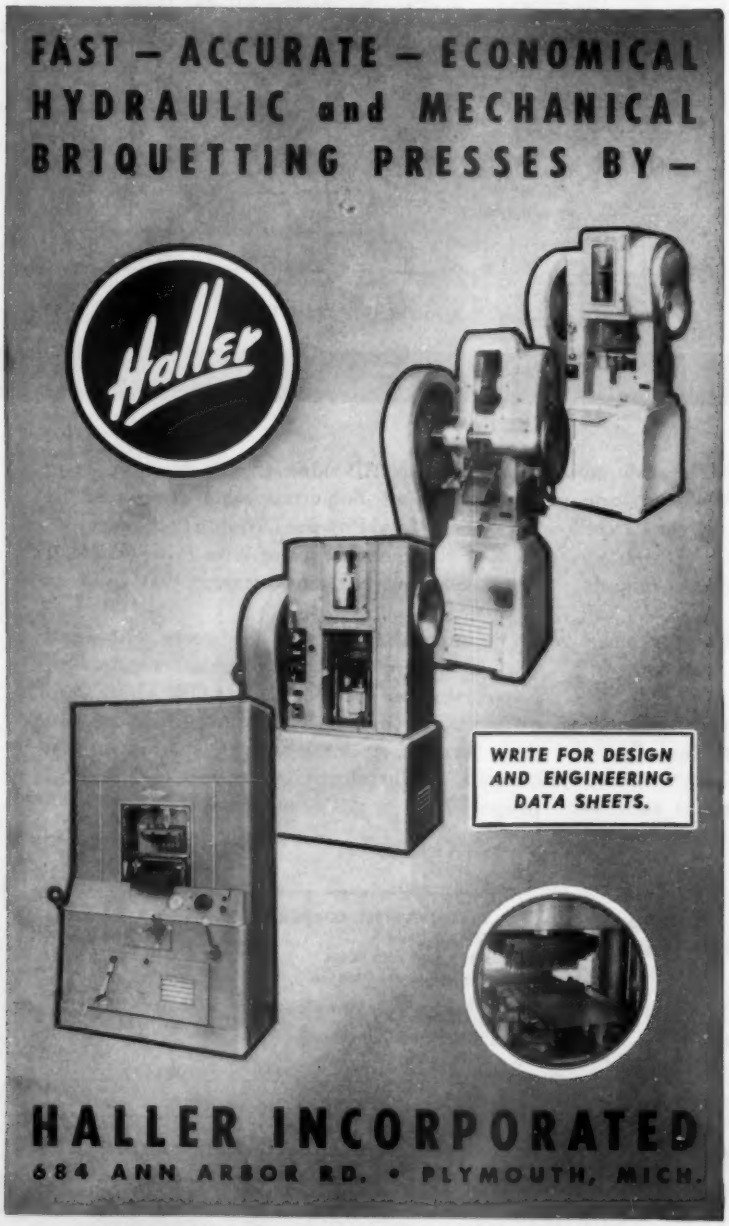
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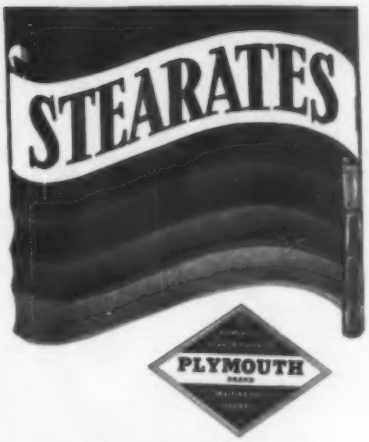

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New York, N. Y.

Fansteel Metallurgical Corp.
North Chicago, Ill.

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Cap-de-la-Madeleine, Quebec, Canada

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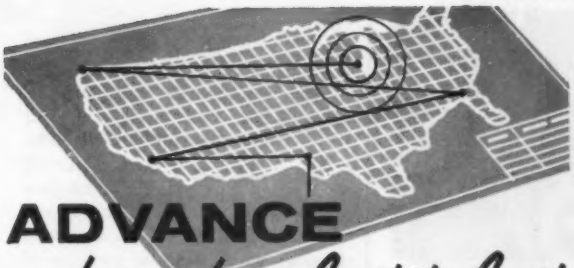

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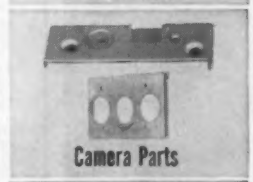

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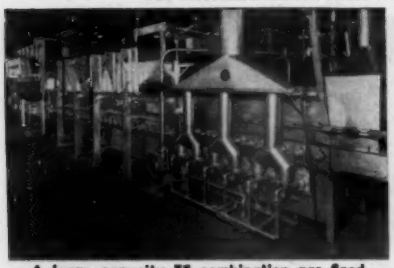
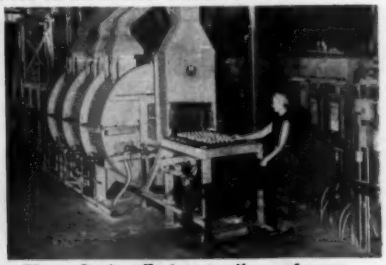


A large capacity EF combination gas fired radiant tube and electrically heated roller hearth furnace for sintering metal powder parts at temperatures up to 2050° F.



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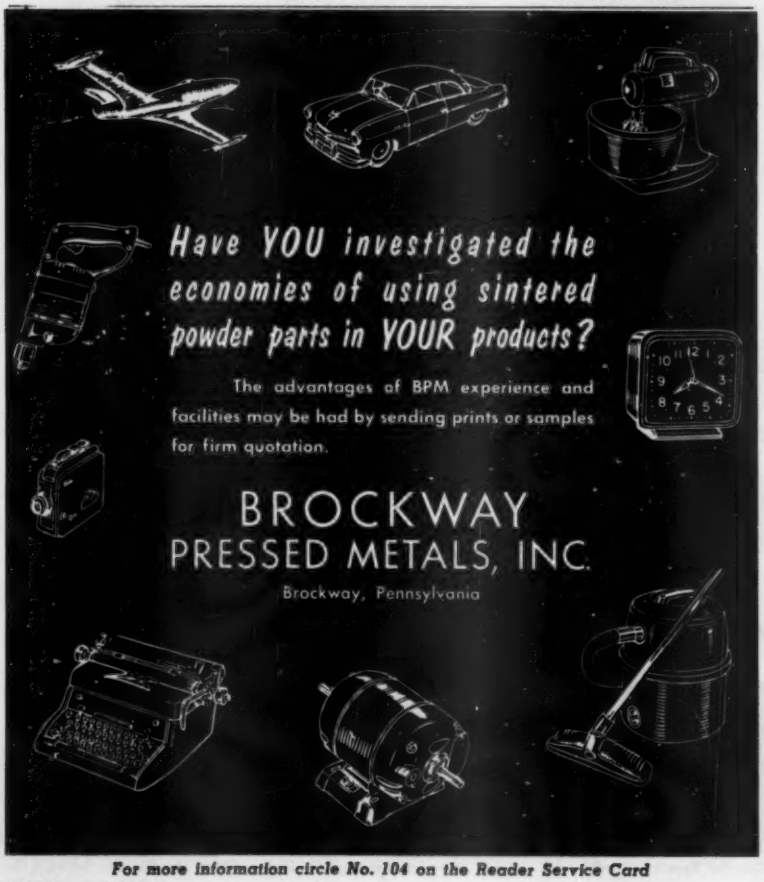
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VANADIUM-ALLOYS OPENS NEW OFFICE

Vanadium-Alloys Steel Company has announced the opening of a new sales office at Sanford, North Carolina. The new office will handle sales and service for the company's tool steels in North Carolina and adjacent areas not heretofore covered by direct sales activities.

The new office will be in charge of E. J. Dalgleish. Formerly plant superintendent of the Roberts Company, he has had broad experience in the use and heat treatment of tool steels and special steels. He is a graduate of North Carolina University.

ZINC INSTITUTE ANNUAL MEETING SET

The American Zinc Institute, Inc. will hold its 39th Annual Meeting at Chicago's Drake Hotel, Thursday and Friday, April 25th and 26th, John L. Kimberley, Executive Vice President of the Institute announced today.

According to Mr. Kimberley the Thursday morning session will be held in conjunction with the Lead Industries Association and The Galvanizers Committee. The program will include reports on the current lead and zinc markets as well as a presentation of the current world supply and consumption picture for both metals.

Kimberley reported that Thursday afternoon will be devoted to an Institute sponsored panel discussion on the future for zinc during the next decade. Panel members will be drawn from the automotive, rubber, paint, galvanizing, and brass industries, he said.

The Friday morning meeting will feature a paper on zinc industry research. This will be followed by a second panel discussion which will outline a course of action for the zinc industry based on recommendations of the consumer panel which met in the earlier Thursday afternoon session.

SHELL PROCESS, INC. EXPANDS

Shell Process, Inc., manufacturers of shell molding machines and allied equipment, recently moved into new and larger quarters at West Springfield, Mass. President E. W. Jahn stated the move was necessary due to increased demand for shell molding and core blowing equipment.

BONE ENGINEERING EXPANDS

A new modern building marks the third expansion of the investment casting facilities for Bone Engineering Corporation, 701 W. Broadway, Glendale, California. The additional 20,000 square feet of space afforded by the new building, near the main plant, will house the very latest investment casting equipment and will include a new melting method employing a 100 lb. furnace.

The production system closely integrates machining, tooling and pattern making with the investment casting facilities. This provides complete facilities under one roof for producing finished products ready for assembly. Production capacity will be stepped up 400% and will necessitate increased employee requirements of over 200%. Additional expansion is anticipated in the near future.

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NEW ALLOY

continued from page 42

TABLE 2. Suggested Composition Range of 17-4 PH For Investment Casting

	Range	Aim
Carbon	0.06 max	0.04
Manganese	0.70 max	0.40
Phosphorous	0.03 max	low
Sulfur	0.02 max	low
Silicon	1.00 max	0.75
Chromium	15.75 to 16.75	16.25
Nickel (No columbium)	3.25 to 4.25	3.75
Nickel (With columbium)	3.75 to 4.75	4.25
Copper	3.25 to 4.00	3.60
Columbium Tantalum	0.45 max	0.25

ture of aging is shown in Figure 5. This datum bears out the earlier statement concerning the increased corrosion resistance and the superior stress corrosion characteristics that accompany over aging.

The foregoing has given, very briefly, the outstanding properties of this alloy. It is of interest to see how these properties were secured by providing a carefully balanced alloy composition. Each of the alloying materials and each of the listed impurities will be examined to determine its individual contribution and effect, if any, of combinations of the different elements. Further, it will be possible with such an examination to determine a more specific casting composition within the broad compositional range first given.

Carbon

This element can be varied over rather wide ranges provided the nickel, nitrogen and other austenite stabilizing elements are varied proportionately. Within the most desirable composition range for other austenite stabilizing agents, however, the 0.07 carbon content should be observed and adequate hardening will be secured with a carbon content considerably lower. Carburization from melting crucibles must be avoided as must surface carburization during any heat-treating operation.

Nitrogen

Nitrogen is not listed in the broad analysis since it is automatically controlled in the manufacture of the alloy. When the alloy is remelted, care must be observed to prevent any nitrogen pick-up since this is an austenite stabilizing material and will decrease hardenability or completely prevent it. Nitrogen should not exceed 0.05% maximum.

Manganese

Manganese like nickel is an austenite stabilizing agent, though much less potent. It also contributes to the development of dendritic segregation and as such should be held to a maximum of 0.70% in castings.

Phosphorous and Sulfur

Both of these elements contribute to dendritic segregation and should be kept as low as possible.

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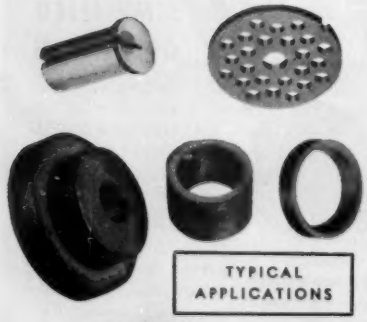
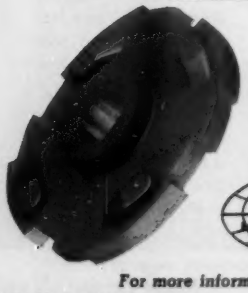
4. Fewer operations
5. No scrap loss
6. Density control
7. Weight control
8. Excellent wear resistance
9. Designs & alloyed materials impossible by conventional methods
10. Cut costs
11. Save skilled man-hours
12. Reduce machining
13. Minimize finishing
14. Self lubrication
15. Low die cost
16. Non-allocable materials
17. No draft angles
18. Parts may be plated
19. Parts may be hardened



TYPICAL APPLICATIONS



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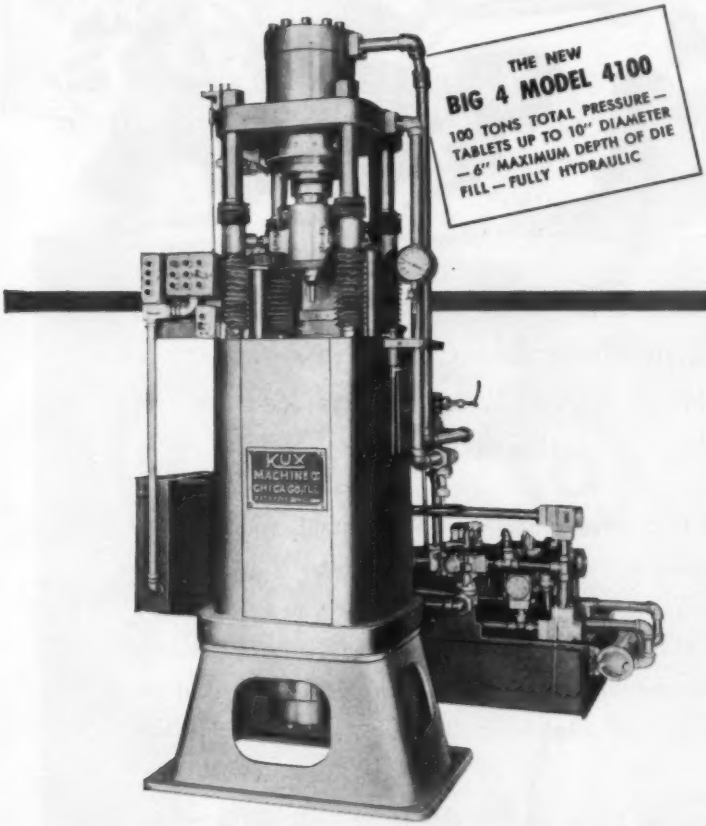

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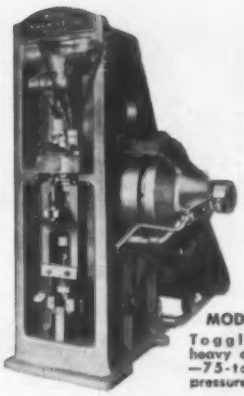
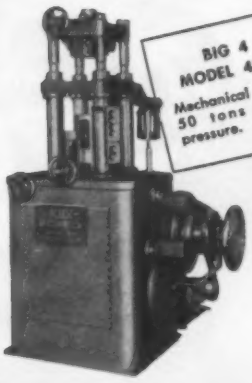
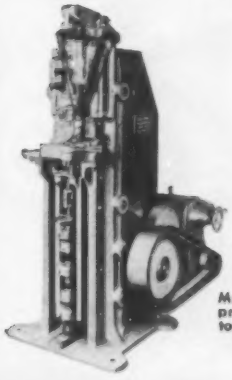
BIG 4 MODEL 4100
100 TONS TOTAL PRESSURE — TABLETS UP TO 10" DIAMETER — 6" MAXIMUM DEPTH OF DIE FILL — FULLY HYDRAULIC



MODEL 65B
Toggle type heavy duty press —75-ton total pressure.



BIG 4
MODEL 450B
Mechanical press 50 tons total pressure.



MODEL 64
Multiple motion press — 30 tons total pressure.

- **Fully Hydraulic**—applies pressure to tablet with both upper and lower punches. Lower punch ejects tablet with full forming pressure.
- **Completely Automatic**—pushbuttons operate machine continuously or through a single cycle with an automatic stop position.
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- **Perfect Punch and Die Alignment**—take-up bushings on tie bars permit punches and die to be held in perfect alignment.
- **Simple Adjustment and Locking**—of die fill and upper and lower pressure strokes.
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- **Accurate Die Filling**—with hydraulically operated shuttle-type shoe. Controlled speed of movement.

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DIE CASTINGS

Many questions have been asked about vacuum die casting. Is it practical on a production basis? How will it affect product design? What about the quality of surface finish? Here, a jobbing die caster reports . . .

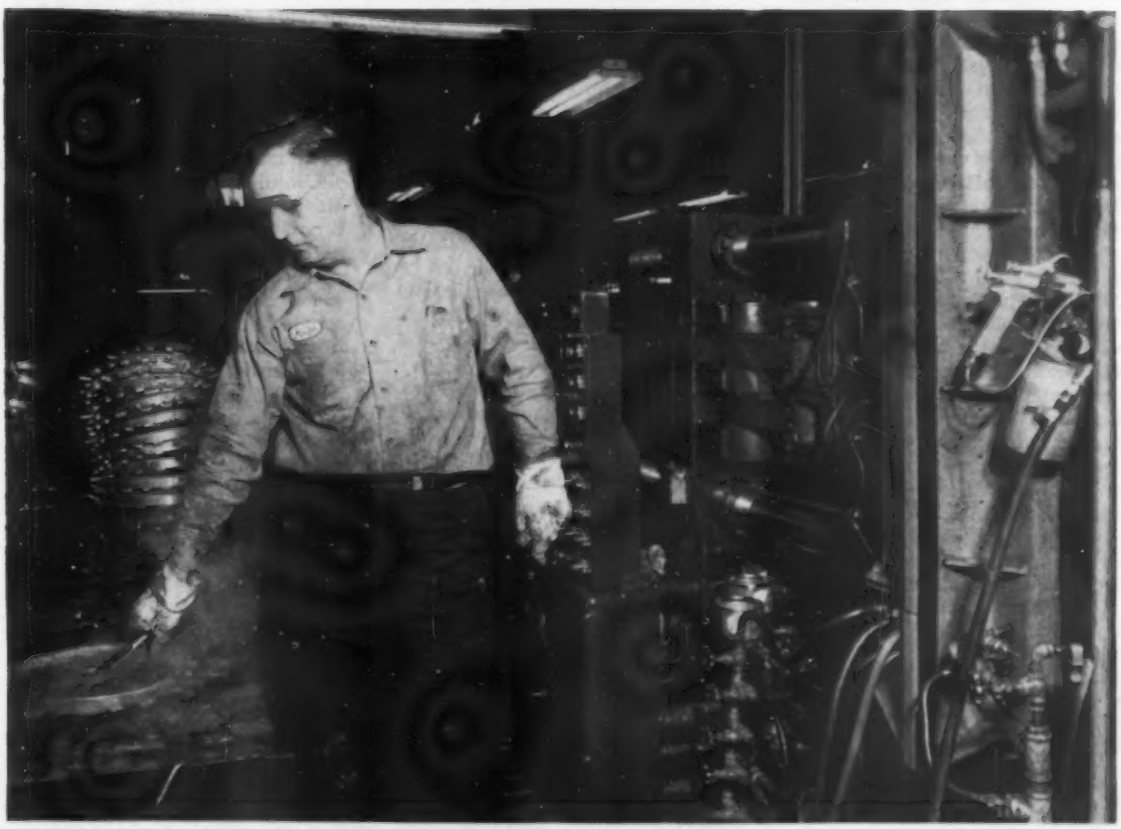
How Vacuum Die Casting Affects Design

SHOULD you be interested in vacuum die casting? A great deal of attention has been given to this development during the past two years, now that standard die casting machines with vacuum systems are available, as well as separate vacuum units to install on existing machines.

Meanwhile, the die casting industry has moved steadily ahead using conventional die casting methods, setting new production records while increasing the size, complexity and quality of castings they are able to produce.

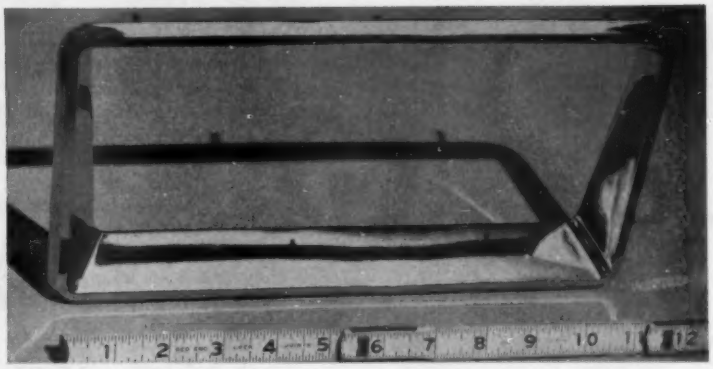
If vacuum die casting is to be of significance in the over-all picture of the die casting industry which last year, using conventional methods, produced 565,000 tons of die castings, it must fill some otherwise unattainable requirement of two individuals . . . the product designer and the casting producer.

For the designer, it must permit product refinements, savings in piece cost, improved finish, superior density or some other tangible benefit; the die caster must get more good castings per hour of operation, fewer headaches in the finishing department, lowered rate of rejects at all stages of processing, ability to to die cast components that would otherwise be outside the limits of die casting, and to get a big enough dollar return to pay for



VACUUM DIE CASTING INSTALLATION at the plant of Lee Silver Service is now in full scale production of chromium plated parts for household appliances. Note the vacuum hood in closed position at the right. This encloses the entire die area for evacuation. Shot injection pressure has been greatly reduced on this Reed-Prentice machine.

PRODUCTION JOBS NOW BEING RUN ON VACUUM DIE CASTING MACHINE



TWO SLIDING CORES are used to produce the refrigerator handle, left, which is die cast at a rate of 160 per hour on vacuum machine, compared with 110 per hour previously.

AT LEAST 17" OF MERCURY is required to make this frame die casting successfully. Production rate, with a die built especially for vacuum, is about 155 pieces per hour.

the extra cost of vacuum equipment.

Can vacuum die casting do any of these things? Will it simplify the production of such castings as pressure-tight hydraulic components or hardware quality components to be chromium plated? Actual production experience is limited, so far, but several companies have installed or are installing this type of equipment.

Their experience is being watched with close interest by all who are connected with the die casting industry . . . by the designers and buyers of castings, as well as those who produce them. Suppliers of metals, too, are keeping an eye on these developments for their effect upon the competitive position of the major die casting alloys.

One large aluminum producer is reported to be investigating this technique for die casting an anodizable aluminum alloy that cannot otherwise be die cast successfully. Possibility of die casting parts with wall sections comparable to those of stampings for the auto and appliance industries is also being investigated.

The technical and trade organizations within the die casting industry are known to be paying close attention to the process. One group has a task force to study vacuum die casting.

The editors of PMM have obtained progress reports from jobbing die casters who have been running production on vacuum die casting machines. Here is what they say . . .

Die castings for appliances

Stove panels 40 inches long and washing machine bezels are among the many thousands of zinc die castings made on a vacuum die casting machine by Lee Silver Service of Detroit, specialists in custom die castings for household appliances.

Most of the company's die castings are chromium plated and/or painted on an integrated finishing line. The need for hardware quality surfaces is one of the reasons the company introduced vacuum methods into its casting department.

Nearly a year ago, the company installed a 400-ton Reed-Prentice #2 Vacucast machine. This machine is being used principally for the problem castings where reject rates had been running high. Such defects as surface porosity, failure to fill small projections, sink spots over heavy bosses or difficulty in getting adequate metal flow through thin sections have been almost eliminated, the company reports.

However, according to Lee Radke, company president, the benefits have not been entirely of a corrective nature. A number of new design advantages which will enable casting buyers to incorporate more features integrally or to reduce casting costs have been made posible.

Use of vacuum die casting, Mr. Radke believes, requires a different approach than standard die casting methods. Such operating conditions as injection and locking pressures, casting cycles, die temperatures, die design and other factors vary considerably when using vacuum systems.

Because injection pressure can be substantially lower when vacuum is applied, the force required to clamp the die halves together can be lessened. This makes it possible to run on a 400-ton machine many jobs which otherwise would have required 600-ton locking pressure. To take advantage of this extra work capacity, the company is having a set of special, oversize platens built to accommodate castings with greater projected area.

At the time of writing, the company had completed many long runs of appliance castings on the Vacucast machine. Three of these, each having large areas to be chromium plated, are illustrated. Some castings have been run in quantities of 75,000 pieces.

PROBLEMS REMEDIED by vacuum die casting this piece include: sinks on surface over heavy bosses, warpage during ejection, poor finish.

How die casting design is affected

When the die cavity is evacuated and injection pressure lowered, metal moves into the cavity with a minimum of turbulence and gas entrapment. Filling of thin sections, small projections and deep contours is readily accomplished.

As a result, some changes in casting design have been permitted. Probably the most significant is the general reduction in wall thickness. By paring 0.010 from a wall that is 0.050 thick, a 20 percent saving in metal can be accomplished. On one casting, nearly a half pound of metal was removed without diminishing the quality of the casting. When projected over a run of 50,000 or more castings, the saving is appreciable.

Possible reduction in wall section makes die casting more competitive with metal stamping on many jobs. Over a period of years, for example, automotive grilles have moved back and forth between die castings and stampings. The new competitive edge in cost due to metal savings, plus the inherent ability to produce more complex shapes, should favor the use of die castings in future years.

Another design change introduced on some castings has been the elimination of extra fillets and webs which had been required to assist the flow of molten metal across thin sections and around abrupt changes in wall direction.

The incorporation of extra detail that could not have been cast integrally has also been made possible. On one large casting now being readied for production, more than 30 bosses have been included to take the place of assembled mounting brackets and posts. The drilling and tapping of 27 holes, plus the cost of stamping and assembling the extra pieces, have all been eliminated.

How die casting operation is affected

"Does it slow the casting cycle?" is likely to be the first question asked concerning vacuum die casting. The present setup at Lee Silver Service can operate at a maximum rate of 167 cycles per hour on the medium-to-large size castings being made there.

Some comparisons of present and previous production rates on specific castings are more indicative than generalizations:

- A 15″ diameter ring that was formerly die cast at a rate of 97 shots per hour with 15 percent rejects is now produced on the Vacucast machine at 131 shots per hour with fewer than two percent rejects.
- A 33″ long bezel that had been run 80 shots per hour with nine percent rejects is reported to be running at 125 per hour with under two percent rejects.
- A refrigerator handle in a two cavity die, with two sliding cores, is running now at 160 pieces per hour compared with 110 previously.

While present rates of production are somewhat ahead of the non-vacuum casting, Mr. Radke comments that the potential speed of casting is considerably greater. Larger capacity pumping and surge tank to speed the rate of recovery, particularly when large cavities are to be evacuated, will add considerable flexibility to the operation. Operation at 20 to 24 inches of mercury is believed to be desirable, but tends to slow down the recovery rate.

Yet despite this, production records for the vacuum machine show that last October, it was running 27 percent ahead of the calculated production rate, and in November, this had climbed to 31 percent over production.

Design of the die is also affected by the conversion to vacuum. Not only are the thinner sections possible, as mentioned above, but the functional elements of the die will reflect the difference in operation. Overflow vents, usually required to bleed off entrapped gas, now serve to help heat the die. Dissipation of heat from die surfaces in the vacuum is faster and more uniform. It is sometimes desirable to locate overflow vents so that they help heat local areas of the cavity.

Location and size of gates, too, are influenced by the different flow characteristics of the metal under vacuum.

Castings can be run with relatively low injection pressure. Very little nitrogen is being used on the majority of casting jobs with the vacuum machine because there is little need for driving the molten metal. Because of the lighter pressures involved, dies can be built lighter. Danger from blow-back and deflection of die halves is eliminated. Of course, the hood surrounding the machine also shields the die parting, protecting the operator from any possible spray of metal.

One unexplained phenomenon is the greater ease of ejection with a vacuum die casting installation. Experience on multiple-core jobs shows that there is little tendency for the casting to freeze over the cores. One possible explanation is that the easy flow of vacuum casting avoids the "packing" action of severe injection pressures. This way, it is thought, there is no tendency for bits of flash to flow in around core pins to cause locking.

Maintenance on bushings, ejectors and core pins is said to be substantially reduced as a result of the reduced pressure on the metal.

How finishing is affected

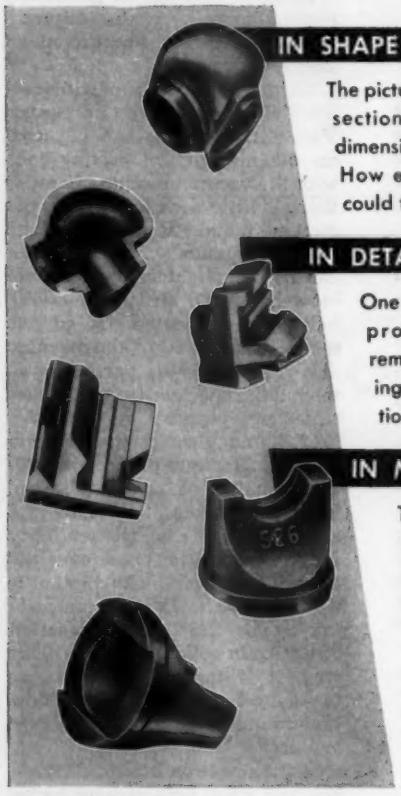
Since the majority of these die castings are to be plated, the question of quality is pertinent. Total rejects for casting defects have been drastically reduced. A study of defects at the finishing line on one run of washing machine castings revealed a rejection rate of 1.75 percent over 30,000 pieces, compared to a normal rate of five percent.

Continued on next page

HERE'S HOW...

INVESTMENT CASTING ANSWERS DESIGN PROBLEMS

Investment Casting is a specific production method that fills a specific function. This process offers much greater latitude in shape, detail reproduction and choice of alloy than any other process.



IN SHAPE

The picture tells the story . . . from the cross section it can be seen that the inside dimensions are greater than the holes. How else but by Investment Casting could this be made in one piece?

IN DETAIL REPRODUCTION

One look quickly shows the machining problems — most of them stock removal. By using an Investment Casting 21 out of 45 machining operations were eliminated.

IN MATERIAL

These nozzles for a highway striping paint sprayer, were produced from cold rolled steel until ground glass was introduced into the paint for its reflective properties. To provide necessary wear resistance these parts are now cast in a non-machinable alloy. Performance was not sacrificed because of material limitations.

These are a few examples demonstrating that the function of the part is the first consideration in design — and — the Investment Casting process was the economical answer.

For more information ask for our brochure . . . its FREE of course.

HITCHINER
Manufacturing Company
MILFORD 7, NEW HAMPSHIRE
REPRESENTATIVES IN PRINCIPAL CITIES

For more information circle No. 44 on the Reader Service Card

VACUUM CASTING

continued from page 113

Baking temperatures have been raised from 250 F to 265-270 F because there is no longer a tendency to blister during baking. The application of baked paint over chromium plated die castings has always been difficult for this reason.

In general, no change in polishing and buffing methods has been introduced. The company's finishing line includes many automatic operations. On one particular job, it was found that the vacuum die cast parts could be run through by the hand buffers as fast as they could be loaded and unloaded from the automatic polishing machine due to the small amount of surface conditioning required.

The total effect of the vacuum die casting installation has been to improve quality of castings, increase output by about 30 percent without using any greater floor area, and reduce the rate of rejects at all stages of production.

DATA IN ADS

continued from page 16

42. **Briquetting Presses**—Design and engineering data sheets are available from Haller, Inc., on their hydraulic and mechanical briquetting presses built for speed, accuracy, and economy.

43. **Sintering Furnaces**—Complete information is available from Harper Electric Furnace Corp. on their line of continuous sintering furnaces.

44. **Investment Castings Design**—A brochure has been published by Hitchiner Mfg. Co. to aid the engineer in designing for the best and most economical use of investment castings.

45. **Powder Metallurgy**—Literature giving full details on powder metallurgy is available from Hoeganaes Sponge Iron Corp.

47. **Die Casting Machines**—Bulletin 5700 from The Hydraulic Press Mfg. Co. gives complete information on their full line of die casting machines.

49. **Die Casting Alloys**—A fact-filled bulletin from Henning Bros. & Smith, Inc., presenting the concentrated experience of

the top men in the industry, tells how to get the best results from die casting alloys.

51. **"Cast to Outlast"**—is the title of a 16-page booklet showing how to keep costs in line on small parts. Published by The International Nickel Co., Inc., it is illustrated with case histories.

52. **Electric Furnaces**—Full information is available from Detroit Electric Furnace Div., Kuhlman Electric Co. on two model sizes of rocking electric furnaces to melt ferrous or non-ferrous alloys for research and small production.

53. **Powder Metal Presses**—An illustrated catalog from Kux Machine Co. describes their line of powder metal presses in a complete range of sizes and models, both mechanically and hydraulically operated.

56. **Aluminum, Magnesium**—die castings, their production and advantages, are described in literature and design information available from Litemetal Dicast, Inc.

66. **"How and When to Hob"**—is the title of a booklet published by Newark Die Hobbing and Casting Co.

67. **Brass Powder**—Detailed information on the design, properties, production, and application of brass and other nonferrous powder parts is contained in a manual offered by The New Jersey Zinc Co.

69. **Increased Production**—A new reference catalog published by Permanent Mold Die Co., Inc. describes their automated molding equipment for increased output, lowered unit costs, and higher quality castings.

72. **Plunger Rings**—Complete information is offered by Precision Piston Rings, Inc. on their unbreakable stainless steel die casting plunger rings.

73. **Metallic Stearates**—Complete technical data from M. W. Parsons — Plymouth, Inc. describes the use of metallic stearates as lubricants for powdered metal molding.

74. **Iron Powders**—Information and technical data on hydrogen- reduced iron powders and other alloys to specifications are available from Pyron Corp.

75. **Die Castings**—A descriptive brochure has been issued by Paramount Die Casting Co. describing the facilities available to help cut costs through the use of die castings.

Continued on next page

The hob (1) a replica in hard tool steel of the finished piece, is pressed into steel blanks to produce hobbed cavities (2) which are then machined (3) for insertion into a die shoe or mold frame.

CUT TOOL COSTS WITH

NEWARK DIE HOBBED CAVITIES

Die hobbing is often the key to lower tool costs. This process produces steel cavities with a minimum of machining, filing and polishing operations . . . and adds the insurance of maximum uniformity in multiple cavity molds or dies.

What's more, as the steel alternately flows and condenses under the hobbing pressure, the mold takes a closer surface grain structure that more faithfully reproduces detail in the finished product.

NEW! *Now producing cast cavities by the Shaw Process*

Write for your free copy of "How and When to Hob." Or let us discuss directly how Newark's complete die hobbing facilities and experience with all sizes and types of cavities may benefit you. No obligation, of course.

NEWARK DIE HOBBING AND CASTING CO.

30 SCOTT STREET, NEWARK 2, N. J. PHONE MArket 3-3305

For more information circle No. 66 on the Reader Service Card

CASE HISTORIES
Die Casting Houses
Radio Antenna Drive
To Eliminate a multiple-piece assembly, a one-piece zinc die casting was selected for the housing of an electrically-driven radio antenna, shown. Use of zinc for the housing also provides improved corrosion resistance without finishing, and reduces machining and assembly operations. Manufactured by the Pioneer Specialty Company, Detroit, the unit is currently being used on the 1956 Cadillac.
The housing is designed to hold all the

DIE CASTING BY PARAMOUNT

5 REASONS WHY

A DIE CASTING PRODUCED A BETTER PART FOR LESS

1. **Eliminated a multi-piece assembly.**
2. **Improved resistance to corrosion.**
3. **Eliminated finishing.**
4. **Reduced machining operations.**
5. **Reduced assembly operations.**

The total result is a part produced of the *finest quality* at the *lowest possible cost!* Call in a PARAMOUNT sales engineer today, let him tell you the complete story.

*PARTIAL REPRINT—
"ELECTRICAL MANUFACTURING"
April, 1956

WRITE FOR FREE DESCRIPTIVE BROCHURE

ALUMINUM ZINC MAGNESIUM
Paramount
DIE CASTING COMPANY
ST. JOSEPH 28, MICHIGAN

Circle No. 75 on the Reader Service Card

76. Vacuum Die Casting—Full details on die casting by the "Vacucast" system for increased production and higher profits are offered by Reed-Prentice Corp.

77. Powdered Metal Parts—in a range of metals are illustrated in a folder from Reese Metal Products Corp., showing their powder metal facilities.

78. Iron Powders—Complete information is available from Republic Steel Corp. on their three grades of iron powder. Included is a description of the powders' "CDF" feature.

79. Heat Control—Bulletin 1.1K5 from the Ross Heat Exchanger Div. of American-Standard gives detailed information on the Ross Exchanger way of safeguarding hydraulic systems from over-heating dangers.

81. Fire Hazard Reduction—Details have been released by Shell Oil Co. on their "snuffer" type hydraulic fluid, with water dispersed in oil to reduce fire hazards near hydraulic systems.

85. Melting Furnace—Catalog 150 has been issued by Stroman Furnace & Engineering Co. describing their "DC" cylinder type furnaces for combination melting and holding aluminum. The furnaces are equipped with contained combustion burners.

86. Zinc Alloy Hardeners—Complete details are available from U. S. Reduction Co. on two new hardeners for use with No. 3 and No. 5 zinc alloys.

88. Non-Ferrous Finishing—Detailed laboratory and engineering reports on the finishing of non-ferrous metals by the "Iridite" process are available from Allied Research Products, Inc.

90. Chromate Coatings—Data sheets and prices are offered by The Chemical Corp. on a chromate conversion coating which imparts a passive surface offering corrosion protection and best adhesive base for paint.

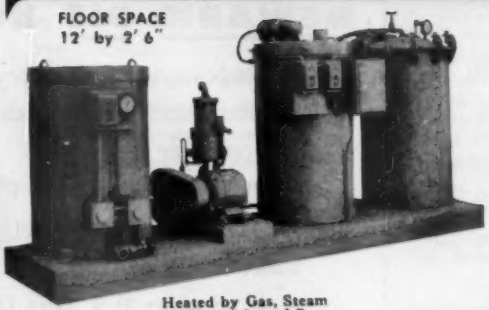
92. For Precision Painting—A 20-page book shows the different types of spray masks offered by Wm. M. Fiore, Inc. The book gives case-study illustrations of their use in decorating plastics, stampings, and die castings.

94. Liquid Compound—for all metal finishing operations is described in a folder published by Hanson-Van Winkle-Munning Co.

96. Barrel Finishing Compounds—Full information on "Honite"

POWDERED CASTINGS SEALED

FLOOR SPACE
12' by 2' 6"



Heated by Gas, Steam or Electricity. AC or DC, 110, 220, 440, 550 Volts.

QUICKER, CLEANER
WITH
IMPREX
IMPREGNATION EQUIPMENT

Cut curing time to five minutes by treating porous powdered castings of any metal with IMPREX Low Pressure Vacuum Impregnation Equipment. Fast-action curing by the unique, new IMPREX Liquid Polymerizer creates greater retention of high-quality IMPREX plastic sealant. Result: Elimination of bleed-out and sweating means cleaner and denser powdered castings. An IMPREX custom-built unit can be installed in your plant within three weeks, increasing production of powdered parts by reducing processing and clean-up time.

IMPREX DIVISION
IDEAL INDUSTRIES, INC., SYCAMORE, ILL.
2023 B SOUTH 60th
MILWAUKEE 19, WISCONSIN

For more information circle No. 95 on the Reader Service Card

barrel finishing compounds for all metal finishing needs is available from Minnesota Mining & Mfg. Co.

97. **Pre-Paint Cleaning, Phosphating**—Bulletin 55-137 from Neilson Chemical Co. describes the "Phosteem" process for cleaning and phosphating metal surfaces for painting.

98. **Barrel Finishing Handbook**—A newly-revised handbook on barrel finishing has been released by Norton Co.

99. **Machine Deburring**—of inaccessible holes can be done with Nobur tools. A complete catalog of these special tools is available from Nobur Mfg. Co.

100. **Metal Cleaning**—Four informative booklets are offered by Oakite Products, Inc.: "Here's the best shortcut in the field of electroplating," "Four good steps toward better electroplating on steel," "What's New for electrocleaning brass and other copper alloys," and "Good news about electrocleaning zinc-base die castings."

102. **Magnesium Dust Control**—The "wet method" of magnesium dust collection and control is the best, according to a brochure from Peters-Dalton, Inc.

103. **High-Temperature Lubrication**—Bulletin 423 from Acheson Colloids Co. discusses the use of colloidal dispersions for lubrication in metal casting and many other applications.

106. **Powdered Metal Parts**—"What You Should Know About Solid Parts from Powder" is the title of design and technical data offered by Supermet Div., Globe Industries, Inc.

109. **Precision Grinding**—Complete information is offered by Cleveland Grinding Machine on their "Visual Grind" system, claimed to offer savings of up to 75 percent in set-up and grinding time.

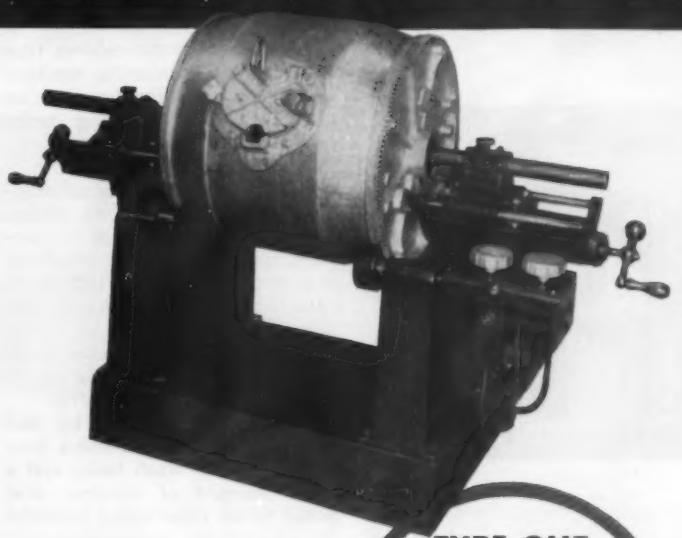
110. **Better Stability**—is one of the advantages of "Resistox" metal powders described in detailed information from The Glidden Co.

111. **Standard Bearings**—National Molded Products, Inc. has issued a listing of standard size bushings and bearings carried in stock. Sizes, load data, etc. are given.

113. **Automatic Casting**—of aluminum is now practical, according to information from Lindberg Engineering Co. describing an automatic aluminum ladling unit.

For Research and Small Production

DETROIT GM SERIES ROCKING ELECTRIC FURNACES



NOW AVAILABLE IN TWO MODEL SIZES

TYPE GMT
CAPACITY—100 lbs.
POWER—50 KW

TYPE GMS
CAPACITY—60 lbs.
POWER—30 KW

With these Detroit Rocking Electric Furnaces, you can melt small quantities of any ferrous or non-ferrous alloy to the required analysis quickly, economically. Indirect arc melting provides accurate heat control plus minimum carbon pickup. Automatic rocking action assures homogeneous alloying, full heat utilization and longer lining life. Electrodes are independently mounted for easy shell interchange. Types GMS and GMT Furnaces are sold complete with transformers, ready for installation. Write today for full information.

FEMA

DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY
1070 26th St. • BAY CITY, MICHIGAN

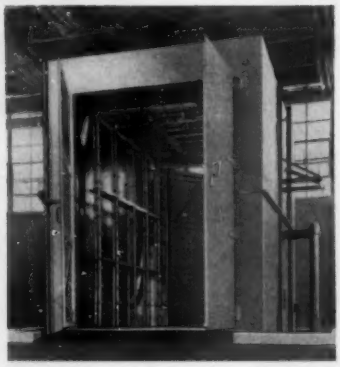
Foreign Representatives: in BRAZIL—Equipamentos Industrias, "Elan" Ltd., Sao Paulo; CHILE, ARGENTINA, PERU and VENEZUELA: M Castellvi Inc., 150 Broadway, New York 7, N. Y.; MEXICO: Cia Proveedora de Industrias, Atenas 32-13, Apartado 27A3 Mexico 6, D. F., Mexico: EUROPE, ENGLAND: Birlec, Ltd., Birmingham.

For more information circle No. 52 on the Reader Service Card

NEW PRODUCTS AND DEVELOPMENTS

Want complete details on these announcements? Use the Reader Service Cards. You'll find them facing page 16 of this issue

WASHING, PROCESSING MACHINE HANDLES ODD-SIZE PIECES



A fully automatic cabinet type washing and processing machine has been especially designed for cleaning and processing large, odd-size metal products.

For cleaning, the machine is equipped with automatically-timed wash and rinse cycles. These can be pre-set for any desired time periods, and operation is automatic. A signal light indicates when the operation is complete.

Cleaned at an elevated temperature, the hot parts or products dry quickly on removal.

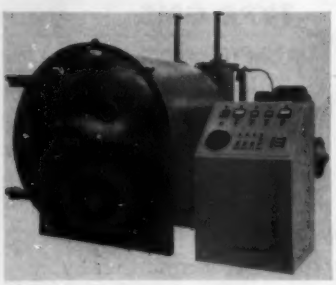
Combination cleaning and phosphate coating materials may be used in the wash tanks and a small amount of chromic acid added to the rinse water provides a basic pre-paint treatment.

Separate wash and rinse piping assemblies mounted on reciprocating carriages supply full spray coverage from four sides. Individual pump and tank units are furnished for each solution. Solutions are returned to their proper storage tank by automatic drain sheets.

The unit is installed in a pit at "track level." Parts are loaded on specially designed trucks which are pushed into the cabinet. Removal may be made from the front, or the load may be advanced through the opposite end of the machine.

The Alvey-Ferguson Co.
For more information, circle No. 207 on the Reader Service Card

VACUUM METALLIZING UNIT REDESIGNED FOR SHORTER CYCLES



A redesigned vacuum pumping system in the Model 427 72-inch vacuum metallizing unit has achieved faster evacuation of the chamber, permitting shorter metallizing cycles and greater productivity.

Simplification of the pumping system through the use of fewer but larger capacity diffusion pumps has eliminated certain vacuum valves and connections, reduced piping, and improved overall production efficiency.

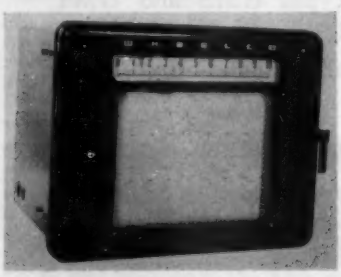
The large-scale production unit features two 16-inch "Ring-Jet" diffusion pumps of greater overall capacity than the three 14-inch pumps in the former design. The 6-inch booster pump which backs up the diffusion pumps also has a higher throughput than the booster previously used.

Other details include a high degree of automation in the control system, with sequenced push-button operation. Interlocked control circuits assure foolproof performance even with ordinary skilled labor.

Selenoid-controlled air-operated poppet valves installed in the vacuum manifold are all remotely operated from the control console located at the front of the unit.

F. J. Stokes Corp.
For more information, circle No. 206 on the Reader Service Card

MULTIPOINT RECORDER MADE EASY TO READ, OPERATE



An electronic multipoint recorder, designed for easy reading, operation, and servicing, can be used for the permanent recording of up to 16 points on one chart.

Designated the Series 8000, the recorder is a null-balance instrument for measurement with sensing units such as thermocouples, radiation detectors, and other devices where the measured variable can be resolved into an electrical signal.

Up to six limit switches may be incorporated to provide for high and/or low signal indication. Up to four switches may have common front set, with additional switches independently adjustable.

The instrument features an electronic, automatically bal-

Continued on page 120

We've discovered

PART OF AMERICA'S FUTURE

underground in Tennessee

As the American economy has expanded, the use of zinc by industry has greatly accelerated, until today's per capita consumption of zinc shows a giant 24% increase over the per capita consumption only seven years ago.

But what about the future? With zinc's importance to Industry's ever-increasing demands, what about the supply?

In recent months, American Zinc has discovered a part of America's industrial future... underground in Tennessee. In the East Tennessee area, mining properties which adjoin American Zinc's long-established Mascot, Tenn., mining operations, exploration and development have confirmed zinc ore reserves underground which are equivalent to *more than 75 years' production at the current rate* of mines now operating in this area.

Tomorrow's zinc for automobile grills and trim... the galvanized coatings for steel... zinc for die-castings and brass... zinc pigments for paints and rubber... now lies underground in American Zinc's Tennessee development.

American Zinc, lead & smelting company

Columbus, Ohio · Chicago · St. Louis · New York · Detroit · Pittsburgh

For more information circle No. 7 on the Reader Service Card

Cannon-Muskegon protects your product's quality . . .

because MASTERMET alloys more than meet your most exact specifications

MASTERMET alloys are premium materials compounded to improve your product . . . *at no extra cost.* Alloys are made from *prime materials only* . . . then alloyed under exact time and temperature control. The latest degasification methods assure a clean, sound product.

What's more, MasterMet alloys are made to *compensate for your melting losses* . . . their chemistry meets all similar specifications.

Finally, Cannon-Muskegon *cleans* alloy of surface oxidation . . . which means less trouble for you. And with each lot you get *certification* of exact chemistry — there's no guesswork. In addition, MasterMet alloys are packed in easy-to-handle, clearly marked containers to simplify selection and storage.

But MasterMet alloy service is not over until the casting has left your shop. Cannon-Muskegon offers expert consultation service to assist you in improving your processing methods and, ultimately, your product.

Next time, call Cannon-Muskegon for your alloy needs — you'll be glad you did!

NOW . . . UltraMet VACUUM-MELTED ALLOYS

Cannon-Muskegon now offers vacuum-melting facilities for the production of iron-, nickel- and cobalt-base alloys up to temperatures of 3100°F . . . and special alloys for industry . . . in ingots or cast billets. We are ready to provide cleaner, stronger and more ductile alloys for remelt . . . sample development and production of vacuum process castings . . . and cast ingots for forging, extruding or machining.

MasterMet ALLOYS AVAILABLE

You can get immediate delivery of high alloys including cobalt- and nickel-base alloys, chromium and chromium-nickel stainless steels. Special alloys include Monel*, Inconel*, Ni-Resist* and Invar — and rare alloys including types with titanium and columbium additions blended to meet your special needs . . . in ingot, shot, billet or cast bars . . . packed in convenient, clearly marked drums. Ask for our "in-stock" list.

Get complete information on MasterMet and UltraMet alloys and services . . . write for New Bulletin.

MASTERMET CERTIFIED ALLOYS FOR INDUSTRY

*(R) International Nickel Corporation

CANNON-MUSKEGON CORPORATION

2871 Lincoln Street Muskegon, Michigan, U.S.A.

METALLURGICAL SPECIALISTS

For more information circle No. 20 on the Reader Service Card

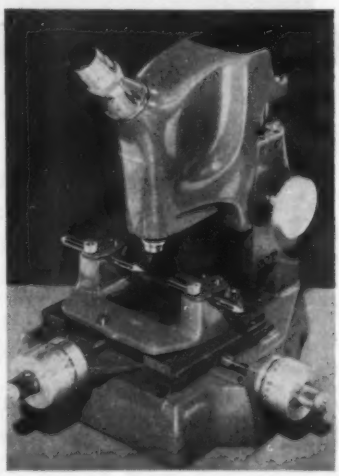
anced, d-c potentiometer when used with thermocouples and radiation pyrometers. The indicating scale has an 11-inch calibrated width, and is illuminated when specified.

Available in seven standard models, the recorder offers a full selection of standard scale ranges. It operates on a 115-volt, 50/60-cycle power supply, with a stepdown transformer available for 230-volt applications.

Total weight is approximately 80 pounds.

Wheelco Instruments Div., Barber-Coleman Co.
For more information, circle No. 205 on the Reader Service Card

TOOLMAKER'S MICROSCOPE . . . has improved illumination



A new microscope has been developed for use by machinists and toolmakers for inspecting and measuring tools, drill jigs, templates, and finished parts.

Manufacturers report the instrument's major advance lies in a unique illuminating system. The light source is built-in and the beam of light is directed down through the objective, giving true vertical illumination. A mirror under the stage plate reflects the light back into the body tube, permitting both surface and contour to be viewed at once.

The stage is mounted on ball bearings and is moved by two micrometer screws.

Standard magnification is 35X, but different objective and eyepiece combinations are available to obtain other magnifications.

Bausch & Lomb Optical Co.
For more information, circle No. 216 on the Reader Service Card

ELECTRIC FURNACES
. . . range up to 2800F

A new line of high temperature electric furnaces for research, quality control and small scale production features complete flexibility of controls and instrumentation to meet any requirement.

Heating elements of silicone carbide provide an operating range up to 2800F. Specially operated doors prevent heat loss and permit free access to the furnace chamber. Standard equipment includes auto-transformer, circuit breaker, input ammeter, 36-step tap switch and temperature control system.

The furnaces are available in six models, ranging in firing chamber size from 7x7x9 inches to 36x36x40 inches. Small units are built with furnace and controls in one compact unit; larger models have a separate transformer housing and control panel.

Harrop Electric Furnace Div., Harrop Ceramic Service Co.
For more information, circle No. 208 on the Reader Service Card

AIRLESS BLASTER
. . . drops cleaning costs

A new batch-type, airless, abrasive blast cleaning machine, cleans sand, scale, oxides, and other contaminants from any work, such as castings, that can withstand a tumbling action.

With an operating load capacity of 28 cu. ft., the machine employs one abrasive hurling wheel that throws 830 lbs. of abrasive per minute. Problems of wheel maintenance have been reduced by the use of newly designed blades, a strain-free holding device, an easy-access wheel guard housing, and a completely revised system of wheel guard liners.

Wheelabrator Corp.
For more information, circle No. 211 on the Reader Service Card

For more information circle No. 40 on the Reader Service Card

another unique GRC die cast component

this movable element unit was Intercast®
...cast-assembled in one operation by GRC

GRC's unique, patented method intercasts multiple-part zinc-alloy units with moving elements in a single, automatic, time-saving, money-saving operation . . . even continuously interlocked assemblies. Units are delivered ready for use.
This INTERCAST technique is an ingenious refinement of GRC's exclusive method of small parts die casting — providing broad design latitude, close tolerances, economies in quantities of 100,000 and more.
Let GRC solve your problems. No size too small! Maximum length: 1¾", Maximum weight: ½ oz. Send for fact-filled bulletin TODAY.

See us at Booth 421, Design Engineering Show, May 20-23rd, N. Y.

World's Foremost Producer of Small Die Castings

GRIES

GRIES REPRODUCER CORP.
157 Beechwood Avenue • New Rochelle, New York • NEW Rochelle 3-8600

122 DAYS IS A LONG TIME
But
AUTO-DIESEL PLUNGER RINGS
have lasted LONGER

A short while back most plunger rings lasted only for hours but the new Auto-Diesel Hardened Steel Plunger Ring lasts for MONTHS. A set was used over 122 days — they were immersed in molten zinc over 800 hours. IN SOME PLANTS THEY ARE GIVING OVER 100,000 SHOTS PER SET. (Names supplied upon request). They are made of cast iron, dieloy cast iron or hardened steel. Anyone operating die casting machines or casting zinc parts can save money. Why not write for details.

Use AUTO-DIESEL 2 or 3 Piece Plunger SEGMENT RINGS for HOT CHAMBER DIE CASTING MACHINES

These rings are especially designed for hot chamber die casting machines. They give LONG LIFE and reduce down-time and maintenance to the minimum. Made of high grade wear resisting iron in sizes from 1½" to 4".

Write for Details

THE AUTO-DIESEL PISTON RING CO.
3135 Superior Avenue • Cleveland 14, Ohio
"RINGS and SHAPES Since 1921"

For more information circle No. 12 on the Reader Service Card

NEWS OF INDUSTRY & ASSOCIATIONS

activities of people, companies & groups in the precision metal molding industries

AUSTENAL ANNOUNCES NEW PLANT CONSTRUCTION

A modern manufacturing plant which will appreciably increase the investment casting capacity of Austenal, Inc., is now under construction at La Porte, Indiana, according to Charles H. Prange, president.

This new facility, to be completed by September 1 of this year, will be the third production unit established by the company. Other plants, including research, alloy manufacturing and general offices, are located in New York City, Dover, New Jersey and Chicago, Illinois.

The La Porte manufacturing facility will consist of a modern, air-conditioned two-story office building and a one-story production unit comprising a total area of 85,000 square feet. Initial operating personnel will number approximately 300 with a potential increase of up to 700 employees. According to Austenal, Inc., the new plant can readily be expanded within the 200 acres the company has acquired for this purpose.

COMPACTED METALS CORP. EXPANDS PLANT

Compacted Metals Corp., one of the leading producers of powdered metal parts in the Chicago area, will move to new and greatly enlarged quarters about April 1. The new plant is located at 99 Greenwood Ave., Waukegan, Ill.

The new facilities will have about five times the floor area of the present location and will allow room for greatly expanded engineering facilities, a complete laboratory and expanded production facilities.

The company is headed by Rudolph Cepon, president; and Joseph Cepon, secretary-treasurer.

LINDBERG-FISHER NAMES NEW CHIEF ENGINEER

C. H. Stevenson, vice president, Lindberg Engineering Company, Chicago, Illinois, announced the appointment of H. E. Pollard as chief engineer of the Lindberg-Fisher Division, manufacturers of non ferrous metal melting furnaces and aluminum pumps.

HADLOCK & TEMTE, INC. EXPANDS

Hadlock & Temte, Inc., Winfield, Illinois, precision miniature die casters, have placed orders for additional machinery which will enable them to treble their production capacity within the next two months. This marks the first expansion of the firm since its inception in October of 1955. A new addition to the Board of Directors is Mr. Paul R. Klingsporn, Jr. who will also serve as Secretary-Treasurer and General Manager. Mr. Harold W. Hadlock continues as President and Mr. Bernard H. Temte as Vice-President.

TWO DESIGN SHOWS SCHEDULED FOR MAY

Two design shows will be staged during May, giving special emphasis to new manufacturing techniques and new materials. Both will be aimed toward improved engineering of tomorrow's products.

The Engineered Castings Show, held in conjunction with the annual meeting of the American Foundrymen's Society, will run from May 6-10 at Cincinnati's Music Hall. In addition to the normal attendance of foundrymen who participate in the AFS sessions, several thousand design engineers are expected to visit the show. Producers of castings will compose the principal part of the exhibition.

The Design Engineering Show which is scheduled for May 20-23, will occupy a large section of New York's new Coliseum, and is expected to attract a very large attendance. This show is not limited to castings, but will encompass a full range of materials, equipment and processes.

Emphasis in both shows will be reduction in cost through the use of modern materials and manufacturing processes. Together, they will probably draw engineers from the majority of important manufacturing concerns in the country.

In conjunction with the show, a Design Engineering Conference will be held, featuring three concurrent sessions: mechanical design, materials and electrical session. It will also include an all-day meeting on Monday, May 20, devoted to procedures in developing new designs.

GENERAL POWDERED METAL MOVES INTO NEW PLANT

General Powdered Metal Products, Inc., custom producers of powdered metal parts, has moved into a new plant in Muller Park, Norwalk, Conn. The new plant has 14,000 square feet, four times the working area of the old plant.

General Powdered Metal Products, a subsidiary of the Holly Corp., is headed by S. B. Harris, Jr., president, and John Caputo, vice president and general manager.

INVESTMENT CASTERS HEAR CASTING RESEARCH REPORT

Government research on castings will highlight the three-day Spring sessions of the Investment Casting Institute in Washington, D. C. April 30-May 2. Progress along these lines will be reviewed by John H. Garrett, executive secretary, Coordinating Committee on Materials, Office of the Assistant Secretary of Defense in an address before the Technical Sessions on May 1.

Also scheduled are papers on engineering properties of pattern waxes, high tensile-low alloy steel, new techniques for non-ferrous precision casting, principle of the frozen mercury process and the requirements of investment casting for airframe application.

The ICI meetings at Washington's Sheraton Park Hotel start with committee and directors' conferences on Tuesday, followed by an all-day technical session on Wednesday and business session on Thursday.

The Institute's completed "Investment Casting Engineering and Design Manual" will be presented at the organization's business meeting. Special speaker at a luncheon on Thursday will be H. B. McCoy, administrator, Business and Defense Services Administration, Department of Commerce, discussing the workings of his department.

Automatic casting of Aluminum *now practical*

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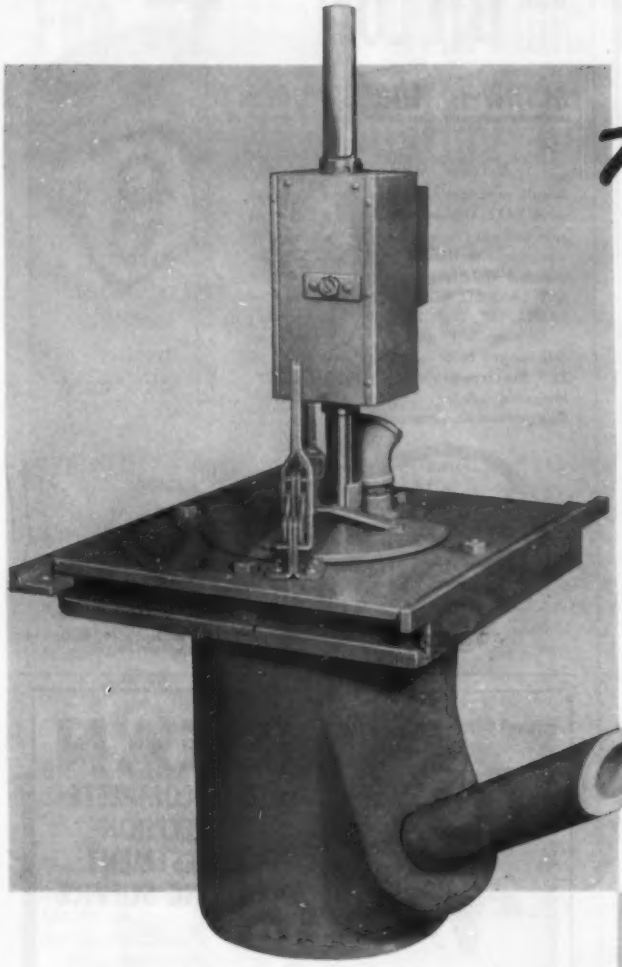

To the best of our knowledge the Autoladle is the first practical automatic aluminum ladling unit yet divised. Thoroughly tested and proven in service, the Autoladle is adaptable to induction, electric resistance or fuel fired reverberatory furnaces. In any installation it offers these advantages:

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- No variation of size of shot due to metal level changes.
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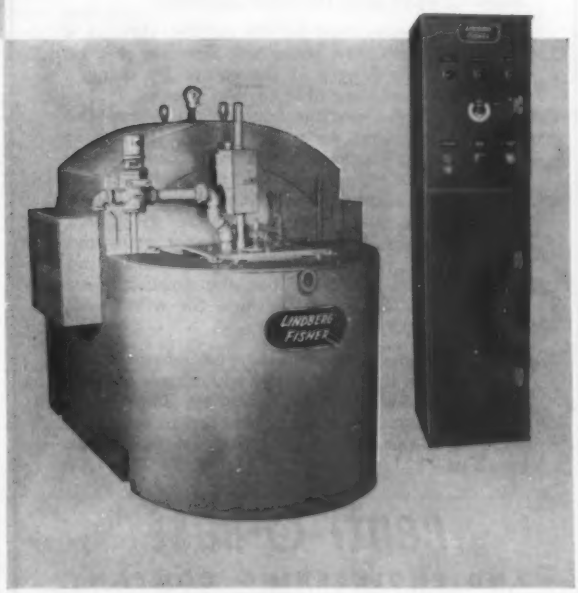

At the right, "Little Joe" is shown installed in a Lindberg-Fisher electric resistance aluminum holding furnace. With it is the panel cubicle and controls which is supplied completely assembled and wired. For complete information on the Autoladle get in touch with your nearest Lindberg Field Representative (See your classified phone book) or write us direct.

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HOW A DOUBLE CONVERTER HOUSING WAS CAST IN ONE PIECE

By F. S. Ross, Vice-President in charge of Engineering Centr-O-Cast and Engineering Co.

The manufacturer of industrial engines had a problem: he needed a cast aluminum housing for a double hydraulic converter. The piece would weigh 70 lbs., and was highly complicated, involving cast-in hydraulic lines, a cast-in hydraulic sump, and numerous apertures, all of which had to be held to close finishing tolerances. Actually, the housing called for three castings, but to justify the design of the part, cost-wise, it seemed essential that it be cast all in one piece . . . and that was the problem.

Different casting methods were tried. Sand casting was attempted first, because it is usually economical. In this case, however, it was not, and the castings were poor. Permanent mold would give the required accuracy, but the intricate internal areas of the part presented a problem. The process that *did* work involved both of the two other techniques: semi-permanent mold. The exterior and the sump section of the part were formed in a permanent mold, while the top and half of the inside were formed in dry sand.

The permanent portion of the mold for this casting is a unique assembly. Rather than being a single mold, it consists of five separate outside shoes forming the exterior of the part, and these shoes move back and forth on five individual axes, making the total assembly similar to the petals on a flower. All are hydraulically operated, allowing us to cycle the mold properly.

We used a heavy riser for the casting, through a heavy dry sand core, with three separate pouring sprues on the flanges of the sump. By using a cover core, we were able to feed the heavy hydraulic oil-tight passages and still preserve the good dimensional accuracy of the permanent mold casting. The lower parts of the casting were very thick but quite sound, and the apertures and flanges were highly accurate. On all faces, only a minimum of stock remained to be machined. Because the casting when in use must withstand terrific strain, we had been concerned with getting sufficient wall thickness, but the finished piece proved that the original design for a ⅜" wall was more than adequate.

By casting this housing in semi-permanent mold, we succeeded in retaining the advantages of both permanent mold and sand casting. The finishing tolerances were very close, the structure was sound throughout, and the cost figure was excellent.

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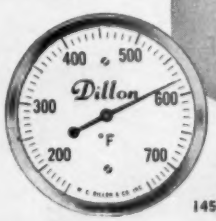

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Fire-Resistant Hydraulic Fluids For The Die Casting Industry

Part 4: Phosphate Ester Types

By W. D. MATTHEWS,
Chemical Division, Celanese Corporation of America

IT has been said before . . . and it becomes truer every day . . . "The most expensive piece of equipment to operate in your plant is the 'FIRE ALARM' ".

When it goes, operation and production stop. Then it's only a question of seeing how much can be saved from destruction, to say nothing of who can be saved from injury.

The amount of money spent annually on lost time, lost production, and recuperating from industrial fires is staggering. Add the millions spent on insurance to underwrite these losses; add the cost of various mechanical systems to indicate fire or sprinkle water on it . . . the figure becomes astronomical.

Prevention of fire in industrial plants today is not strictly classified as a safety measure. It is more and more an economic consideration just as realistic as raw material cost reduction or increased output, and can affect the earnings statement just as profoundly. Since the day it opened its doors, the U. S. Patent Office has been besieged with gadgets and schemes guaranteed to prevent fires. As of today, we are still waiting for one that will work. To be sure, many reliable systems act to extinguish or retard fires once they have started; but, in some of these cases, the cure itself may be worse than the disease.

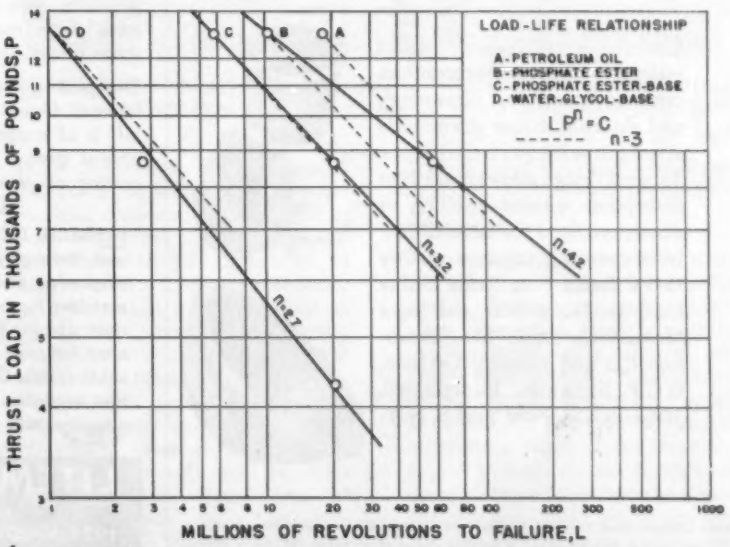
The best approach to the fire problem lies in preventing its start, not in putting it out. Efforts expended by producers of fire-resistant hydraulic fluids are in that direction. It is not necessary to use highly flammable petroleum products to do hydraulic work. The same work can be done with other liquids which provide a vastly increased margin of safety without altering the characteristics or service life of any properly designed hydraulic system. The fact that the apparatus in question does not do a particularly hazardous type of work, or even operate in a location where it is exposed to some abvious hazard, is not justification for considering it "safe". Oil in the reservoir and drip pans, and perhaps running down to the floor from a small leak, renders the machine vulnerable to fire and will support combustion which may have started in a far removed section of the plant.

The case for fire prevention in industrial plants is being ably supported and actively pursued by leading insurance associations and fire underwriters. They have enthusiastically acclaimed the efforts of fire-resistant hydraulic fluid manufacturers toward the prevention of further fire losses.

Types

Four basic types of fire-resistant hydraulic fluids are available to industry today:

1. Pure phosphate ester fluid.



1. DIFFERENCES in effects of fire resistant hydraulic fluids on bearings.

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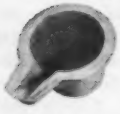

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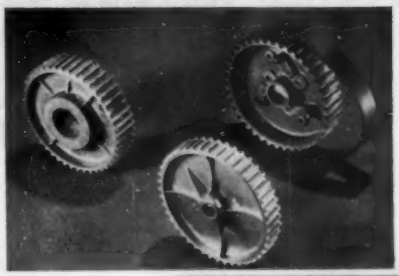
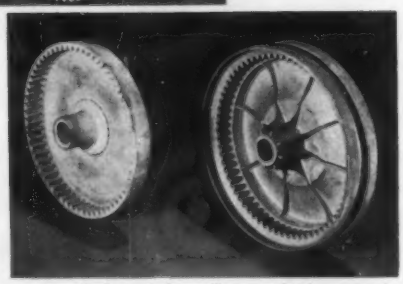
No need to crystal gaze . . . there are good reasons for

GEARS DIE CAST in ALUMINUM or MAGNESIUM





First of all, these new lightweight alloys which contain certain inherent qualities may help in avoiding design difficulties. Die cast gears, used extensively for low load operation, can satisfactorily replace machined or hobbed gears. For example: In addition to their savings in weight, aluminum offers corrosion resistance — magnesium offers sound damping. Both can be die cast accurately . . . offer fine appearance . . . help meet competitive situations by effecting cost savings through the virtual elimination of labor otherwise required for machining, finishing and assembling.

Following today's trend for effecting weight reductions in products, even though they are not necessarily of the "portable" type, many manufacturers find that through use of these alloys, shipping weights are favorably effected.

The photographs show: *Above*—Cog Belt Gears. *Below*—Internal Gears for Lawn Mower Wheels; the one at the left is of magnesium, the other aluminum. Note the peripheral groove for the tire which is integral to the die casting process.

Let's Talk It Over . . .

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PLANT AND EXECUTIVE OFFICES

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2. Phosphate ester based fluid.
3. Water and glycol mixtures.
4. Water and oil emulsions.

These cannot properly be compared on an overall basis, but must be individually examined according to their conformance with each of the many criteria for a suitable hydraulic fluid. Some standards might be:

1. Fire Resistance
2. Lubricity
3. Ease of handling (toxicity, etc.)
4. Preparation necessary for installation
5. Effect on machinery
6. Effect on packings, seals & gaskets, etc.
7. Ability to reclaim & reuse
8. Stability
9. Cost

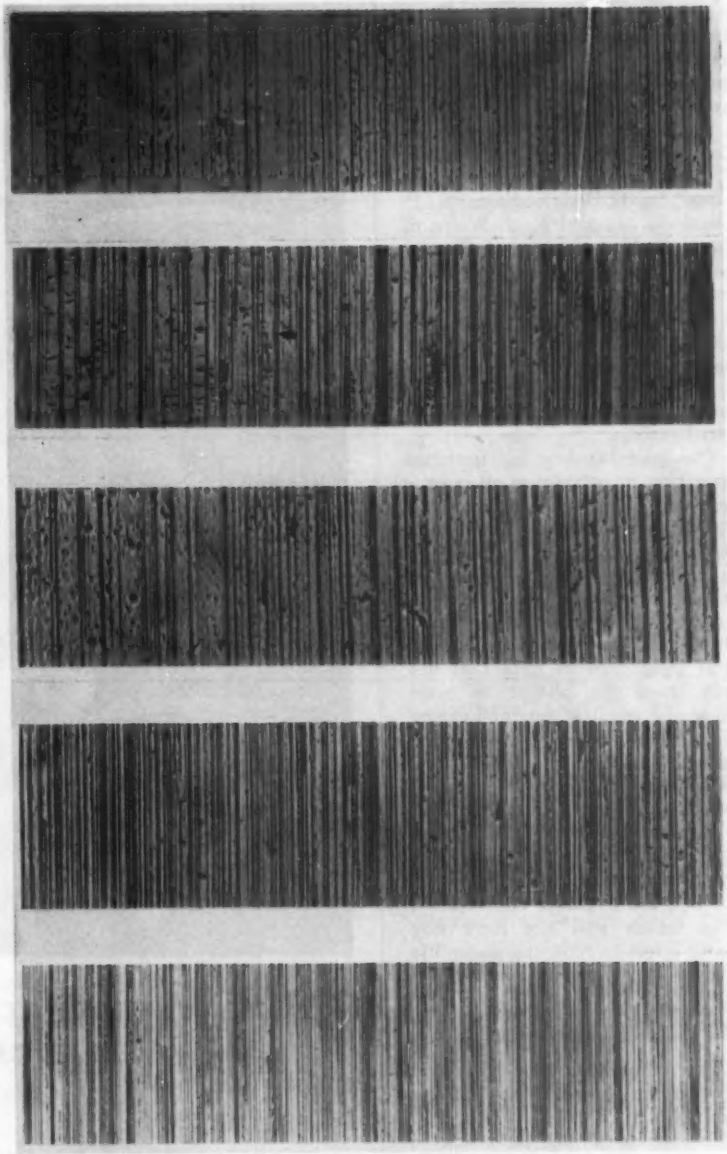
The fact that there are many others ways to evaluate these fluids further complicates this issue. Only a careful study of each fluid, with its intended application in mind, allows the hydraulic engineer to make a satisfactory choice.

Phosphate Esters

Let us turn our attention to the pure phosphate ester fluids and see how an evaluation of their characteristics suit the requirements of a typical plant.

These fluids are known as Cellulubes, made by the Chemical Division of Celanese Corporation of America. They are available in six controlled viscosities ranging from 90 S.S.U. to 1000 S.S.U. at 100° F. Thus we can select a fluid with viscosity to match, or closely approximate, just about any grade of hydraulic oil now in use. It is especially important to note that the viscosities of these fluids are not achieved by use of additives or thickeners, but rather by so-called "molecular building"; actually constructing molecules of the same general classification which exhibit varying physical properties.

This concept of chemically compounded, rather than blended, fluids results in a number of advantages to the hydraulic engineer especially with regard to subsequent maintenance. These will be brought out later as the various properties are dicussed. Suffice it to say, that these six different fluids are essentially the same chemically, and physically, excepting for viscosity. By reason of their chemical compound nature, they possess mechanical and chemical stability exceeding, in many cases, that of petroleum oils. They are more resistant to oxidation (and accompanying acid formation) than are the natural petroleum products. Furthermore, acids formed by the intentional decomposition of these phosphate esters in the laboratory, are basically acid moieties of the organo phosphorous or phenolic types, which have significantly less corrosive effect on most metals than the carboxylic acids formed by the thermal destruction of petroleum products.



2. PHOTOMICROGRAPHS of the surface of ball-path, top to bottom: unused path, phosphate ester, petroleum oil, phosphate ester base, water-glycol base.

Lubrication

As a matter of interest, since the phosphate esters have polar groups, their molecular structures align themselves along a metallic surface creating a strong adhesive bond between the fluid and the metal. This contributes to the so called "Extreme Pressure" lubricating value of the fluid and would indicate better lubrication down to boundary conditions than entirely non-polar petroleum oils. A cross section of industrial experience in almost every con-

ceivable type of equipment shows the Phosphate Esters to have essentially the same lubricating service life as premium grade petroleum products.

Figure 1 is from "A Study of Combustion Resistant Hydraulic Fluids as Ball Bearing Lubricants" by H. V. Cordiano, E. P. Cochran, Jr., and R. J. Wolfe of the N. Y. Naval Shipyard, Brooklyn 1, New York. The complete article was printed in Lubrication Engineering, July-August, 1956. This work shows the difference in the effect of combustion resistant hydraulic fluids on the modal life of angular contact ball bearings.

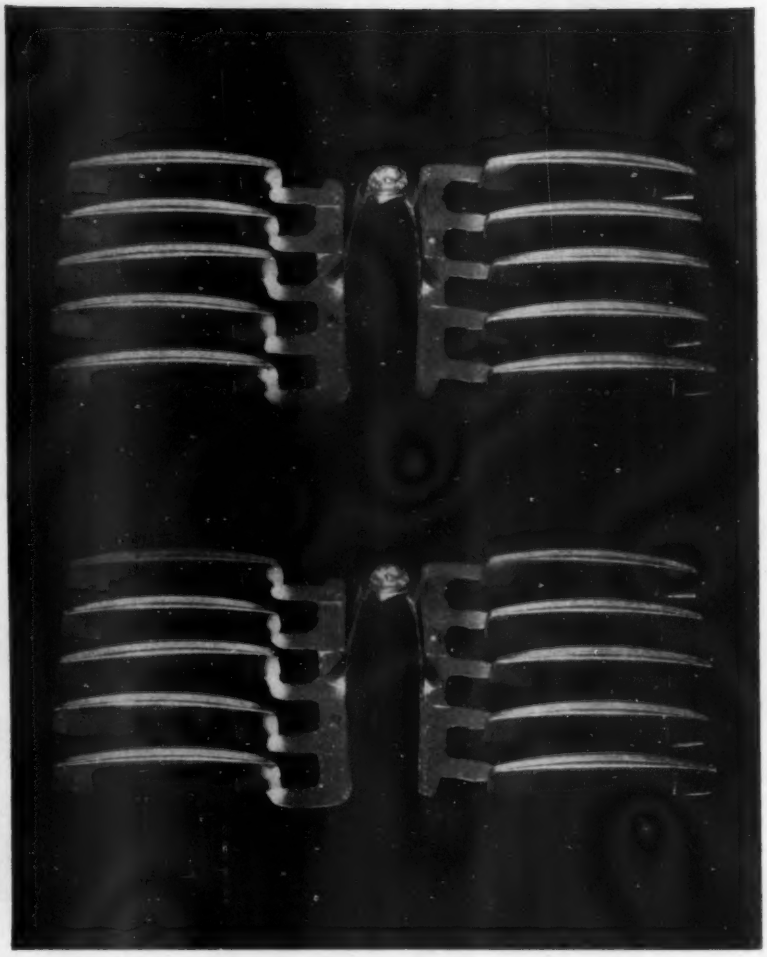
The load-life line for bearings operating in petroleum oil is represented by the dotted line (A). The slope of this line (n-3) is a representative value conforming to bearing design characteristics established for oil. The actual results of this test using the phosphate ester is plotted as line B. It is significant to note that not only does the phosphate ester show the greatest modal bearing life of the fire-resistant fluids tested, but that at loads below 8000 pounds the plot suggests that the phosphate ester is actually superior to petroleum oil as a lubricant. This is further demonstrated in Figure 2.

Thus, the engineer can select a fluid which will not have any major effect in reducing pump life or decreasing hydraulic efficiency.

Fire Resistance

The other basic concern is that of fire resistance. How safe is this fluid?

One point should be borne in mind . . . fire-resistant does not mean non-flammable! Every fire-resistant hydraulic fluid on the market today will burn under certain conditions. Each one, however, has the ability to resist fire to varying degrees depending upon its composition and the circumstances of its exposure to fire or heat. Literally dozens of tests are used by various laboratories to determine relative fire resistance. Some of these tests are specially designed to be advantageous to one particular fluid, some to be dramatic. But the majority of these measuring devices stem from the technology and experience of the petroleum industry. Whether or not such tests are suitable standards by which non-petroleum products are to



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be judged is a highly controversial point. This particular subject is now under investigation by the A.S.T.M.

In operation of hydraulic equipment, the largest percentage of accidents occur from the rupture of some vessel, line, or joint releasing hydraulic fluid under high pressure. Such a break can dribble, shoot, and spray fluid over a wide area. (Spurts of 50-60 feet away from the machine are not uncommon.) The fluid may, therefore, be exposed to hot metal surfaces, open flames from gas burners and torches, molten metals in die casting, electrical arcs and/or sparks, and a variety of other ignition sources. The reaction of the fluid to these different circumstances, therefore, is of prime importance to the user. The phosphate ester fluids have the following typical properties (may vary slightly according to viscosity):

Flash point	455°F
Fire point	685°F
Autoignition temp	over 1175°F
SAE-AMS Hot Manifold test	1400°F
Molten Metal Ignition Test (flood)	1700°F
Molten Metal Ignition Test (drip)	1500°F

In addition, a spray of atomized phosphate ester at 1000 psi was impinged on a hot metal plate (over 1200°F) in the presence of flame. There was no ignition and no flash back. With the same test on a 1400°F surface, there was intermittent ignition but still no flash back.

These tests, while reproducible in the laboratory, do not always reflect the exact conditions encountered in a busy plant and the figures should be used as a guide or comparison, rather than as absolute values around which a safety program is built.

A most important feature of the phosphate esters is that they do not flash back from the ignition source to the point of system ruptures. A good part of the danger involving the use of flammable petroleum products stems from the fact that, once ignited, they will continue to burn at ordinary temperatures and will support and distribute the combustion wherever the liquid goes. This gives rise to flash back to the originating point and continuance of the fire until the fuel is consumed. The Phosphate Ester fluids will burn only at the point of

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ignition, and then only when the fluid temperature *at that point* is maintained well above its fire point limit. Thus, combustion is confined and uncontrollable spread of fire is prevented. This feature, although difficult to measure by standard tests, contributes a major part of the definition of "fire resistance". At the same time it should be kept in mind that the fire-resistant properties of the phosphate ester fluids are inherent in their chemical nature, and are not affected by continued use at temperatures considerably above the normal operating ranges. Since they contain no additives or aqueous components, no fluid maintenance is required to assure the user of continuing fire-resistance.

Handling & Toxicity

Over the years a great many things have been said regarding the toxicity of Phosphate Esters. Many of them have resulted from a lack of knowledge of these materials rather than from constructive factual data. Quite a few people were, and still are, prone to classify phosphate ester materials as undesirable, or questionable, or worse, until they could prove themselves otherwise.

Within the past three years, a great deal of light has been thrown on this subject by producers, industrial toxicologists, and various medical groups of the U. S. Government. While some questions remain to be resolved before the toxicity of these products is finally established, or completely defined, enough is known so that a realistic appraisal of their nature can be made for industrial applications. Users are cautioned not to take these products internally. Beyond this, however, standard plant hygienic routine appears adequate to safeguard workers against harmful effects which could be attributed to phosphate esters. As a matter of fact, these same fluids, purchased by the U. S. Navy according to Mil Spec H-19457, are subject to toxicity approval by the Navy which has devoted much time and effort to the study of this matter. The pure phosphate ester fluids contain no chlorinated hydrocarbons, eliminating the possibility of chlorine bearing fumes being evolved by contact with hot surfaces.

Corrosion

Phosphate Esters are non-corrosive by nature and may be used with any of the metals commonly used in the manufacture of hydraulic equipment. They have no deleterious effect on zinc or cadmium plated parts such as strainers or fittings. Due to their non-corrosiveness and their extremely low vapor pressure, these fluids present no vapor phase corrosion problem, and require no inhibitor to control this action.

Foaming

Foaming tendencies of an hydraulic fluid require consideration. Excessive foaming, or a tendency to retain foam once it has formed, can be a vital factor in reducing pump life and causing erratic cycle operation. Proper pressures will not be maintained throughout the system, and the lubrication of the pump may break down sufficiently to damage it permanently within just a few minutes. As tested in the laboratory according to ASTM D-892, the phosphate ester fluids (example: 220 S.S.U. at 100°F) are properly classified as non-foaming.

Continued on page 132

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FLUID MAINTENANCE

Fluid maintenance can sometimes be a fairly time-consuming and, consequently, expensive procedure. Having no additives and no aqueous component, phosphate esters require no maintenance other than normal filtration which is an integral part of most hydraulic circuits. Any standard type of filter may be used including the activated clay or Fuller's Earth type, metallic disk, cellulosic pack, etc. The non-additive nature of the materials allows for minimum particle size filtration without fear of removing any added ingredient.

The filtration process may be repeated as often as desired, vastly increasing the effective life of these particular fluids by reclamation. The economic nature of this characteristic more than offsets the slightly higher initial cost; and, barring excessive contamination through dilution with petroleum oil, these products could be expected to have an indefinite service life. In actual industrial plant experience, a number of cases have been reported where the useful life period has been extended considerably beyond the useful life of the petroleum oil formerly used. In general, however, most lubrication engineers schedule these fluids for replacement at approximately the same intervals as for petroleum oils.

EQUIPMENT CONVERSION

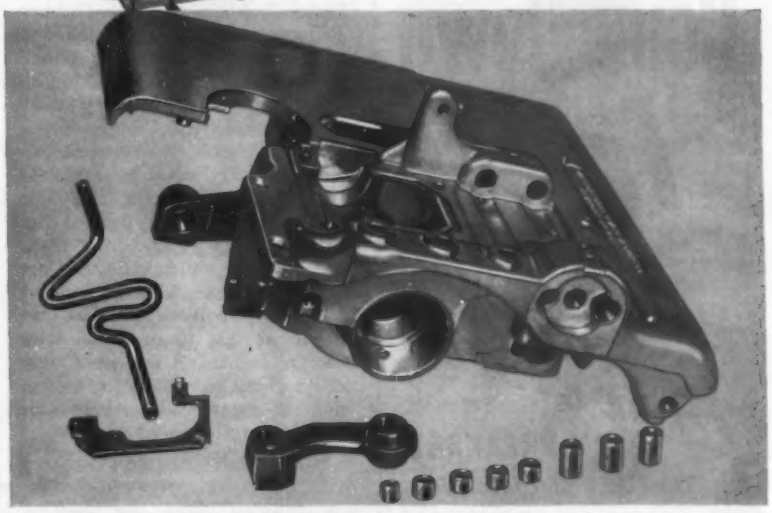
Conversion of equipment now using petroleum, or other hydraulic fluids, to the use of phosphate ester fluids is an important, but not burdensome task. Assuming that petroleum oil is now in the circuit, a general method of procedure would follow along these lines:

Drain the system as thoroughly as possible, blowing down lines and valves where practicable. Since the phosphate ester fluid is miscible with petroleum, any oil remaining will mix with the new fluid without precipitation or separation. However, petroleum as a contaminant will reduce the fire resistance. Therefore, petroleum contaminants should be kept below 3 to 5%.

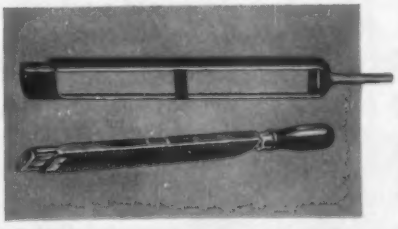
Interior surfaces of sumps, reservoirs, etc., which are painted should be cleaned and the paint removed. The phosphate ester

DIE CASTING REPORT

Intricate casting solves tough redesign problem . . . on new HIGH SPEED SEWING MACHINE



Lightning fast starts and stops are only one feature of this Willcox & Gibbs rugged commercial sewing machine which does seaming, hemming, edging and serging operations. High performance is due to progressive design engineering which resulted in a zinc frame die casting (shown above) with 11 inserts, two loose pieces in the die and core pulls in four directions. For over twenty years our engineers have cooperated closely with Willcox & Gibbs Sewing Machine Company, in redesigning this and other castings to achieve lowest possible unit costs consistent with scheduled production.



DIE CAST ALUMINUM FRAME ADDS RIGIDITY

The new "Surform" manufactured by the Stanley Tool Division of the Stanley Works is housed in a holder of die cast aluminum. Lightness and rigidity, plus rapid duplication of identical parts with a good smooth surface dictated the selection of the die-casting method.

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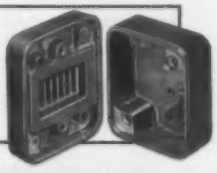
Sonic switch housing for Zenith called for absolute uniformity at reasonable cost. A zinc die-casting provided the answer. Precision, too, does drilling, tapping and honing as part of its integrated service.



The Precision Division is organized to meet all your die-casting requirements. Its integrated facilities include design, engineering, die building, machining, painting, plating and packaging. Try doing business with a firm which offers one contract, one responsibility. We welcome your inquiry.

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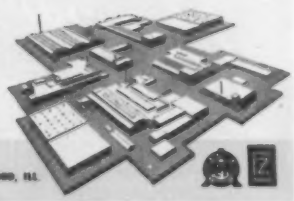

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will lift or soften most common paints, and this could lead to clogging of valves, etc., if not forestalled in advance. Since vapor phase corrosion is not a problem, interior surfaces would not require painting except in unusual circumstances. Special paints, resistant to the fluids, are available from a number of manufacturers.

Packings, seals, gaskets, etc., should be made of materials compatible with the Phosphate Ester fluids. These are generally of the Butyl Rubber, Silicone Rubber, Teflon and Nylon types, as well as a number of specialty products recommended by individual manufacturers. The ordinary elastomers, neoprene, Buna types, etc., used in petroleum service will generally swell in the presence of the phosphate ester, and should be replaced at time of conversion. However, only those gaskets, "O" rings, etc., that are in dynamic use, where a moving action is involved, need be replaced at this time. Static seals may be left intact and need only to be changed when the equipment is dismantled for repair or regular maintenance.

When replacing seals for use with phosphate esters, it is recommended that the packing manufacturers be consulted, since they are familiar with these fluids and with the requirements of the seal in the particular machine involved. Most major packing producers are fully equipped to provide such service and assistance.

Where piping joints have been disturbed during conversion, it is advisable to re-assemble them using a pipe-joint compound resistant to these fluids. Several types are readily available.

After the system has been reassembled, and filled with the new fluid, it is suggested that a filter, if not already provided, be put in the line for the first day or two of operation. This will serve to collect any foreign particles dislodged during the work and any bits of paint etc. which the phosphate ester might have removed.

Beyond these few steps, no further maintenance is required and regular plant routine can be adopted to these units. Some precautions regarding possible contamination with petroleum oil are advisable, since more than a few percent of such oil will begin to impair the fire resistance and destroy the purpose for which it is intended.

Properly installed, and properly used, these fluids provide a level of safety unattainable with petroleum products, without sacrificing any of the hydraulic qualities of the flammable oils.

NEW ALLOY

continued from page 108

It is, therefore, possible to secure a gain in ductility with a much smaller sacrifice in strength. The presence of columbium also contributes to the good high temperature properties over long periods of time. At high levels, however, columbium contributes to dendritic segregation and should be kept on the low side of the range. Since it is a strong ferrite former, columbium should never be used above the amount given in the broad composition.

Aluminum

Aluminum is not included in the broad analysis and should be avoided if possible. In some cases it is necessary to deoxidize with this element to secure a completely killed melt. In these cases not more than 1½ lbs. per ton of steel should be used. In these cases the small residual amount of aluminum will not be harmful.

Desirable Analysis Range

From the above discussion of the function of each alloying element a composition range for investment casting can be set up, table II.

With this composition and by following the heat-treatment given earlier, castings of uniform and desirable properties can be made.

ALLIED RESEARCH APPOINTS HORELICK

Allied Research Products, Inc., Baltimore, Maryland manufacturers of the Iridite Chromate Conversion Coatings and ARP Plating Chemicals, announces the appointment of Mr. Jules Horelick as Staff Executive Assistant to H. C. Irvin, President.

In his new capacity, Mr. Horelick will play a major role in Allied's new and extensive program of product expansion and development and will be directly responsible for market research.

OPPORTUNITIES

jobs & equipment

Opportunities rates: $20 for the first column-inch; $15 for each additional column-inch payable in advance. To answer box number advertisements, address responses to the box at Precision Metal Molding, 812 Huron Rd., Cleveland 15, Ohio. Closing date: 1st day of month preceding publication.

POSITIONS OPEN

REPRESENTATIVES WANTED — We are changing our sales policy and are interested in discussing the sales of our melting furnace equipment with representatives in various districts outside of New York and Chicago. We manufacture a complete line of gas and oil nonferrous melting furnaces in all sizes and types. Also interested in a salesman for our home office. Write Stroman Furnace & Engineering Company, 9900 Franklin Avenue, Franklin Park, Illinois.

OPPORTUNITY for man experienced in precision investment casting to set up and operate new department. Prefer someone with background in metallurgy and experience in maunfacturing to government aircraft specifications. Send resume of experience and other details to: Norgren-Stemac, Inc., 1277 So. Cherokee St., Denver 23, Colorado.

MANUFACTURERS AGENTS WANTED — To handle well-established repeat supply item sold to pressure die casters. Leader in its field. Splendid earnings opportunity with a product that is a "household name" in the die casting industry. Give full details concerning lines handled. We are especially interested in frequency of contact you now have with pressure die casters. Write Box No. 4357.

WANTED—SALES ENGINEER—INVESTMENT CASTINGS—Expanding, modern firm requires aggressive sales engineer. Foundry sales experience, mechanical or metallurgical background essential. Coming growth opens excellent possibilities for exceptional income and promotions. Send complete resume to: Box No. 4157.

DIEMAKING FOREMAN WANTED — Plastic or die casting molds. Extraordinary opportunity, stable growing progressive firm in New York City area; top pay; employee benefits; profit sharing. Write fully to Box No. 4257.

EQUIPMENT

FOR SALE — Lester Phoenix Model 35 Type HHP2 die casting machine, cap. 6½ lbs. zinc, 100 ton, 18" x 20" die size, 9" opening. Cpl. with melting pot, hyd. pump, valves, controls. Aaron Machinery Co., Inc., 45 Crosby St., New York 10, N. Y. Walker 5-8300.

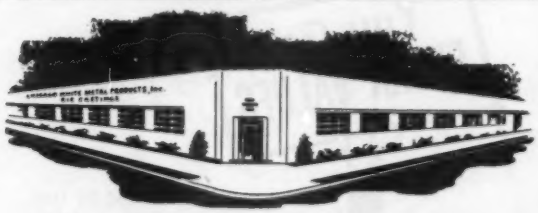
FOR SALE — Two Kux BA12 die casting machines. Still in operation. Will be available for sale in May. The Yale & Towne Mfg. Co., Salem, Virginia.

LICENSEES UNDER SHAW PROCESS PATENTS EXPAND

The Shaw Process, a method of casting molds and dies for the metal and plastics molding industries, has shown a steady gain in the number of licensees since the process was first introduced into this country a short time ago.

An English development, this foundry technique permits the rapid manufacture of dies and molds by casting them in ceramic molds.

Full details of the process and a list of foundries who are set-up to make molds and dies by this method is available from the Shaw Process Development Corp., Port Washington, N.Y.



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MPA PROGRAM SET FOR SPRING MEETING

The final program for the 13th annual meeting of the Metal Powder Association in Chicago has been announced. The meetings this year will be on Tuesday, April 30 and Wednesday, May 1. The technical program includes:

Tuesday Morning:

Activated Sintering, M. Edier; Production and Characteristics of Chemically Precipitated Nickel Powder, K. O. Cockburn, R. J. Loree and J. B. Hawarth; Production and Characteristics of Chemically Precipitated Copper Powder, V. S. Ryan; Current Developments in the Rolling of Both Ferrous and Non-Ferrous Powders, J. D. Shaw and W. V. Knopp.

Tuesday Afternoon:

Fiber Metallurgy, C. H. Sump and W. Pollack; Primary Considerations in the Design and Use of Sintered Metal Parts, R. Talmage; Panel Discussion—Presses for Compacting Metal Powders, J. D. Shaw, moderator.

Wednesday Morning:

New Developments in Metal Powder Filters, J. H. Mott; New Developments in Diamond Products Using Metal Powders, L. Kuznick; Metal Powders in Brazing and Soldering, P. D. Johnson; Metal Powders in Pyrotechnics and Explosives, J. Sachse;

Wednesday Afternoon:

Superfine Iron Powders, M. W. Freeman and J. H. L. Watson; Fundamentals of Powder Metallurgy, C. Kuczynski; The Sintering of Iron-Copper-Carbon P. Ulf Gummeson; Powder Metallurgy in the Manufacture of Roller Chains, C. L. Richares. Tuesday Morning (Simultaneous Session);

How to Take Advantage of Magnetic Core Materials, J. A. Roberst, A. Schmeckenbecher and G. Ludewig; Magnetic Cores in Miniature Electronic Circuits, D. M. Hodgin.

Tuesday Afternoon:

Characteristics and Applications of Ceramic Permanent Magnets, C. A. Maynard; Characteristics and Present Requirements of Ferrites, R. D. Harrington; Latest Developments in Magnetic Storage and Switching Applications, J. W. Schallerer; Thermal Expansion of Ferrite Materials at Temperatures near the Curie Point, W. R. Buessem.

ICI PRESIDENT TOURS MEMBER FOUNDRIES

Making a tour of member companies in Cleveland, Ohio during February, K. W. Thompson, Investment Casting Institute president made an inspection visit to the new Alloy Precision Castings Co. plant. Shown above are (left to right) Henry Bryk, Alloy Precision operations manager, Frank W. Glaser, executive vice president,, Mr. Thompson and Michael Gladstone, Alloy Precision's general sales manager.

The purpose of Mr. Thompson's trip was the investigation of new investment casting techniques and processes such as were used to produce the pictured casting.

Alloy Precision Casting Co. is unique among foundries doing this general type of work since it is the only one in the country that makes parts by both the lost wax (wax or plastic patterns) and the frozen mercury pattern methods.

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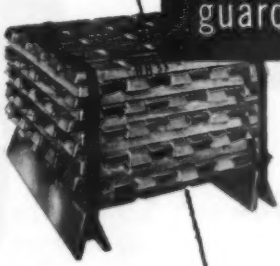

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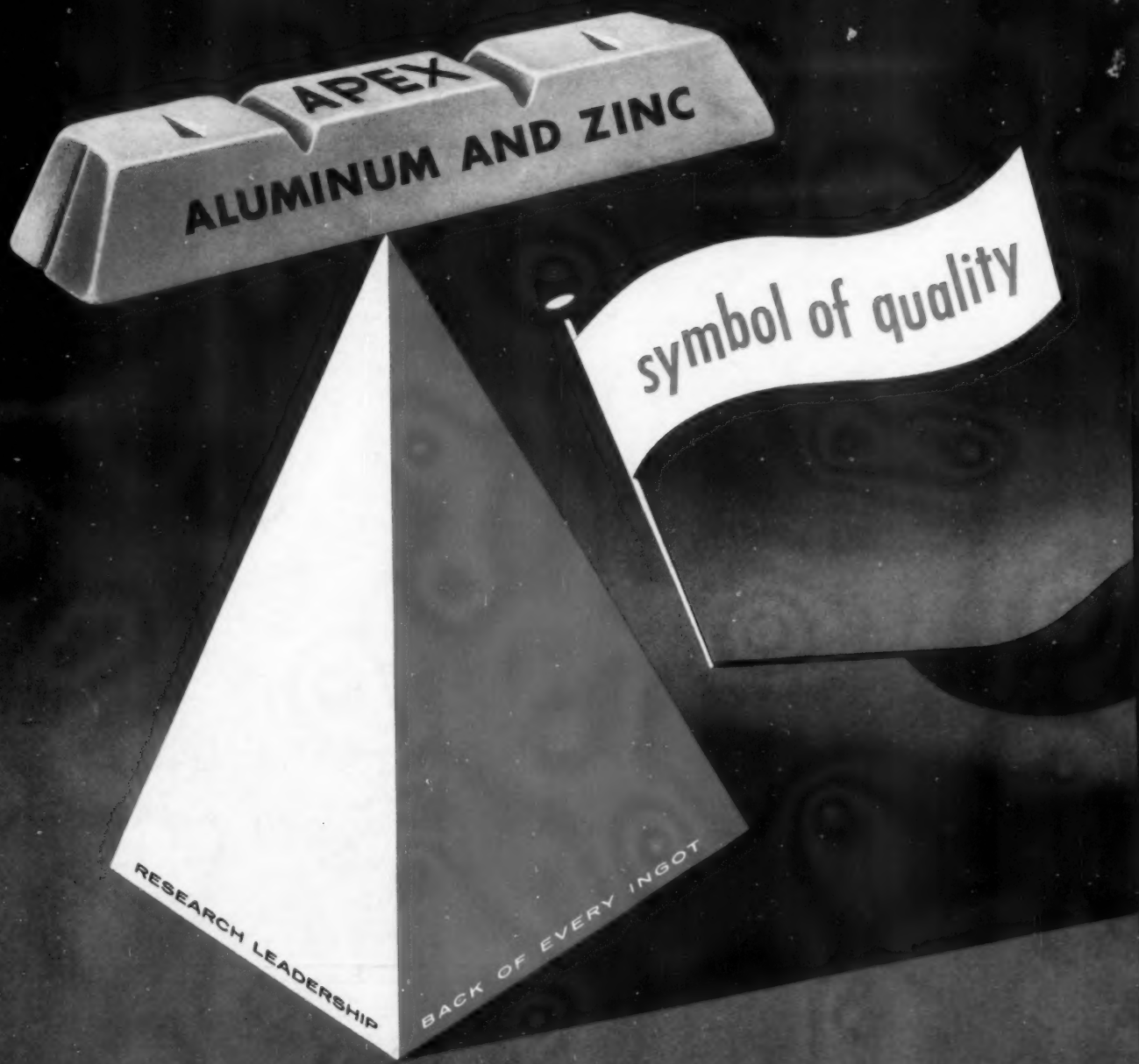

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